Service and Maintenance Manual

Model 601S

3120746

August 6, 2003

ANSI

ADE System Identification

All machines after S/N 60444 incorporate the ADE system. The following machine serial numbers prior to S/N 60444 also utilize ADE: 58993, 58998, 59222, 59223, 59275, 59281, 59315, 59319, 59352, 59358, 59361, 59769, 60253, 60254, 60286, and 60242

A Machine that incorporates the ADE (Advanced Design Electronics) system can be outwardly identified by the analyzer connection at the base of the platform control box as shown by the arrow.

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SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

A GENERAL

This section contains the general safety precautions which must be observed during maintenance of the aerial platform. It is of utmost importance that maintenance personnel pay strict attention to these warnings and precautions to avoid possible injury to themselves or others, or damage to the equipment. A maintenance program must be followed to ensure that the machine is safe to operate.

⚠ WARNING

MODIFICATION OF THE MACHINE WITHOUT CERTIFICATION BY A RESPONSIBLE AUTHORITY THAT THE MACHINE IS AT LEAST AS SAFE AS ORIGINALLY MANUFACTURED, IS A SAFETY VIOLATION.

The specific precautions to be observed during maintenance are inserted at the appropriate point in the manual. These precautions are, for the most part, those that apply when servicing hydraulic and larger machine component parts.

Your safety, and that of others, is the first consideration when engaging in the maintenance of equipment. Always be conscious of weight. Never attempt to move heavy parts without the aid of a mechanical device. Do not allow heavy objects to rest in an unstable position. When raising a portion of the equipment, ensure that adequate support is provided.

⚠ WARNING

SINCE THE MACHINE MANUFACTURER HAS NO DIRECT CONTROL OVER THE FIELD INSPECTION AND MAINTENANCE, SAFETY IN THIS AREA RESPONSIBILITY OF THE OWNER/OPERATOR.

B HYDRAULIC SYSTEM SAFETY

It should be noted that the machines hydraulic systems operate at extremely high potentially dangerous pressures. Every effort should be made to relieve any system pressure prior to disconnecting or removing any portion of the system.

Relieve system pressure by cycling the applicable control several times with the engine stopped and ignition on, to direct any line pressure back into the reservoir. Pressure feed lines to system components can then be disconnected with minimal fluid loss.

C MAINTENANCE

⚠ WARNING

FAILURE TO COMPLY WITH SAFETY PRECAUTIONS LISTED IN THIS SECTION MAY RESULT IN MACHINE DAMAGE, PERSONNEL INJURY OR DEATH AND IS A SAFETY VIOLATION.

- NO SMOKING IS MANDATORY. NEVER REFUEL DURING ELECTRICAL STORMS. ENSURE THAT FUEL CAP IS CLOSED AND SECURE AT ALL OTHER TIMES.
- REMOVE ALL RINGS, WATCHES AND JEWELRY WHEN PERFORMING ANY MAINTENANCE.
- DO NOT WEAR LONG HAIR UNRESTRAINED, OR LOOSE-FITTING CLOTHING AND NECKTIES WHICH ARE APT TO BECOME CAUGHT ON OR ENTANGLED IN EQUIPMENT.
- OBSERVE AND OBEY ALL WARNINGS AND CAUTIONS ON MACHINE AND IN SERVICEMANUAL.
- KEEP OIL, GREASE, WATER, ETC. WIPED FROM STANDING SURFACES AND HAND HOLDS.
- USE CAUTION WHEN CHECKING A HOT, PRESSURIZED COOLANT SYSTEM.
- NEVER WORK UNDER AN ELEVATED BOOM UNTIL BOOM HAS BEEN SAFELY RESTRAINED FROM ANY MOVEMENT BY BLOCKING OR OVERHEAD SLING, OR BOOM SAFETY PROP HAS BEEN ENGAGED.
- BEFORE MAKING ADJUSTMENTS, LUBRICATING OR PERFORMING ANY OTHER MAINTENANCE, SHUT OFF ALL POWER CONTROLS.
- BATTERY SHOULD ALWAYS BE DISCONNECTED-DURING REPLACEMENT OF ELECTRICAL COMPONENTS.
- KEEP ALL SUPPORT EQUIPMENT AND ATTACHMENTS STOWED IN THEIR PROPER PLACE.
- USE ONLY APPROVED, NONFLAMMABLE CLEANING SOLVENTS.

REVISON LOG

March, 1998	- Original Issue
February 1, 1999	- Revised
February 14, 2001	- Revised
August 24, 2001	- Revised
April 18, 2002	- Revised
August 6, 2003	- Revised

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SECTION 1. SPECIFICATIONS

1.1 CAPACITIES

Fuel Tank

26 US. Gallons (98.4 L).

Hydraulic Oil Tank

Approx. 32 U.S. Gallons (121 liters), 26 gal. (98.4 L) to the full mark on sight gauge.

Hydraulic System (Including Tank)

Gasoline/Diesel Power - 37.2 U.S. Gallons (140.8 l).

Torque Hub, Drive

17 ounces (0.50 l).

NOTE: *Torque hubs should be one half full of lubricant.*

Engine Crankcase

Ford LRG-425 Gas w/Filter - 4.5 quarts (4.25 l).

Deutz F3M1011F Diesel w/Filter - 6.3 quarts (6 L).

1.2 COMPONENT DATA

Engine - Gas. (Water-Cooled)

Manufacturer/Model - Ford LRG-425.

Oil Capacity.

4.5 Quarts (4.25 l) w/Filter.

Idle RPM - 1000.

Low RPM - 1800.

High RPM - 2800.

Alternator - 40 Amp, Belt Drive.

Battery - 85 Amphour, 550 Cold Cranking Amps, 12 VDC.

Fuel Consumption.

Low RPM - 3.45 GPH (13.06 lph).

High RPM - 4.60 GPH (17.41 lph).

Horsepower - 54 @ 2400 RPM, full load.

Cooling System - 16 Quarts (15.14 l.).

Engine - Diesel (Liquid-Cooled)

Manufacturer/Model- Deutz F3M1011F.

Oil Capacity.

5 Quarts (4.5 l) Cooling System.

6.3 Quarts (6 L) w/Filter.

11.3 Quarts (10.7 L) Total Capacity.

Low RPM - 1800.

High RPM - 2800.

Alternator - 60 Amp, belt drive.

Battery - 1000 Cold Cranking Amps, 210 Minutes Reserve Capacity, 12 VDC.

Horsepower - 48 @ 3000 RPM, full load.

Drive System

Drive Motor Displacement.

Standard - 2.8 cu. in. max. 1.1 cu. in. min.

(46 cm[3] max. 18 cm[3] min.).

Drive Hub Ratio.

Standard - 43:1 (4WD).

Drive Brake - Automatic spring applied, hydraulically released disc brakes.

Steer System

Tires - 14 x 17.5, directional tread, pneumatic, tire pressure -90 PSI (6 Bar).

Tires - 14 x 17.5, directional tread, foam filled.

Toe-in, adjust for 1/4" (6.35 mm) overall.

Swing System

Swing Motor Displacement - 4.62 cu. in. (75 cm[3]).

Swing Brake - Automatic spring applied hydraulically released disc brakes.

Swing Hub Ratio - 50:1.

Hydraulic Gear Pump (at 1800 RPM)

7.9 GPM (29.90 lpm).

Pump Displacement - 1.02 cu. in. (16 cm[3]).

Clockwise Rotation.

Auxiliary Power Pump

2.6 GPM (9.84 lpm) @ 1200 PSI. (82.7 BAR.

Pump Displacement - 0.244 cu. in. (14 cm[3]).

DC Motor.

Clockwise Rotation.

Hydraulic Filter - In-line

Return - Bypass Type.

10 Microns Absolute.

Charge.

10 Microns Absolute.

Hydraulic Strainers (In Tank).

30 Microns.

1.3 PERFORMANCE DATA

Travel Speed.

4WD - 4 MPH (6.44 Km/hr.).

Gradeability.

(4WD) 45%.

Turning Radius (Outside)

2WS/4WD - 20 ft. 4.6875 in. (6.21 m).

4WS/4WD - 11 ft. 2.6875 in. (3.42 m).

Turning Radius (Inside)

2WS/4WD - 14 ft. 3.875 in. (5.25 m).

4WS/4WD - 5 ft. 3.625 in. (1.22 m).

Boom Elevation

+60 ft. 2 13/16 in. (18.36 m) -6 ft. 1 11/16 in. (1.87 m).

Machine Weight approximately

-4WD - 22,510 lbs. (10,211 kg).

Machine Height (Stowed)

8 ft. 4.75 in. (2.56 m).

Machine Length (Stowed)

Over Drive Axle - 27 ft. 8.125 in. (8.44 m).

Machine Width

2WS/4WD - 7 ft. 11.4375 in. (242 m).

4WS/4WD - 7 ft. 11.375 in. (2.42 m).

Wheel base

8 ft. 1.50 in. (2.48 m).

1.4 FUNCTION SPEEDS

Machine Orientation When Doing Speed Tests

Lift: Telescope Retracted. Lift Up, Record Time, Lift Down, Record Time.

Swing: Boom at Full Elevation. Telescope Retracted. Swing the Turntable off center and stop. Swing the opposite direction and start the test when the turntable is centered up. This eliminates ramp up and down on the controller affecting times.

Telescope: Boom at Full Elevation; Telescope Retracted; Telescope Out, Record Time. Telescope In, Record Time.

Drive (Forward/Reverse): Test should be done on a smooth level surface. Drive Select Switch should be set to High Engine. Start approximately 25 ft. (7.62 m) from the starting point so that the unit is at maximum speed when starting the test. Results should be recorded for a 200 ft. (60.96 m) course. Drive Forward, Record Time. Drive Reverse, Record Time.

Drive (Above Horizontal): Test should be done on a smooth level surface. Drive Select Switch should be set to Low Engine. The boom should be raised above horizontal. Results should be recorded for a 50 ft. (15.24 m) course. Drive Forward, Record Time. Drive Reverse, Record Time.

Platform Rotate: Platform level and completely rotated one direction. Rotate the opposite direction, Record Time. Rotate the other direction, Record Time.

Articulating Jib: Platform level and centered with the boom. Start with the Jib down. Jib Up, Record Time. Jib Down, Record Time.

Test Notes

1. Stop watch should be started with the function, not with the controller or switch.
2. All speed tests are run from the platform. These speeds do not reflect the ground control operation.
3. The platform speed knob control must be at full speed (turned clockwise completely).
4. Function speeds may vary due to cold, thick hydraulic oil. Test should be run with the oil temperature above 100° F (38° C).
5. Some flow control functions may not work with the speed knob clicked into the creep position.

Table 1-1. Function Speeds (In Seconds)

Function	Time
Lift Up	46-60
Lift Down	33-43
Swing Right & Left*	79-101
Telescope Out	50-67
Telescope In	35-40
Platform Rotate Right & Left**	16-25
Drive Forward & Reverse (4WD)	37-45
Drive Above Horizontal - Forward & Reverse (2WD & 4WD)	43-136
*Max 10% Difference Between Left & Right **Max 15% Difference Between Left & Right	

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1.5 TORQUE REQUIREMENTS

Table 1-2. Torque Requirements

Description	Torque Value (Dry)	Interval Hours
Bearing To Chassis	See Note	50/600*
Bearing To Turntable	See Note	50/600*
Wire Rope	15 FT. LBS (20 Nm)	150
Wheel Lugs	170 FT. LBS. (231 Nm)	150

*Check swing bearing bolts for security after first 50 hours of operation and every 600 hours thereafter. (See Swing Bearing in Section 2.)

NOTE: *When maintenance becomes necessary or a fastener has loosened, refer to the Torque Chart to determine proper torque value.*

1.6 LUBRICATION

Ford LRG425 Engine

Single Viscosity Oils (SF, SF-SE, SF-CC, SF-CD).

When Outside Temperature is Consistently	Use SAE Viscosity Number
-10°F. to +60°F	*10W
(-24°C. to +16°C.)	*10W
+10°F. to +90°F	*10W
(+12°C. to +32°C.)	20W-20
Above +32°F. (+0°C.)	30
Above +50°F. (+10°C.)	40

Multi-Viscosity Oil. (SF, SF-SE, SF-CC, SF-CD)

*Not recommended for severe service, including high RPM operation

When Outside Temperature is Consistently	Use SAE Viscosity Number
Below +10°F. (+12°C.)	*5W-20
Below +60°F. (+16°C.)	5W-30
-10°F. to +90°F. (-23°C. to +32°C.)	10W-30
Above -10°F. (-23°C.)	10W-40 or 10W-50
Above +20°F. (+7°C.)	20W-40 or 20W-50

*Not recommended for severe service, including high RPM operation

NOTE: *Crankcase oil must be high quality detergent type meeting API service classification SF, SH, SG.*

Deutz F3M1011F Engine

Single Viscosity Oil (CD-SE, CD-SF).

When Outside Temperature is Consistently	Use SAE Viscosity Number
-20°F. to +25°F. (-29°C. to +4°C.)	*10W
+5°F. to +50°F. (+15°C. to +10°C.)	20W-20
+40°F. to +85°F. (+4°C. to +30°C.)	30
Above 75°F. (24°C.)	40

Multi Viscosity Oil (CD-SE, CD-SF)

*This viscosity can be used at colder temperatures with engine oil preheating.

When Outside Temperature is Consistently	Use SAE Viscosity Number
-40°F. to +75°F. (-40°C. to +24°C.)	*5W-30 (Synthetic)
-15°F. to +70°F. (-26°C. to +21°C.)	10W-30
-15°F. to +85°F. (-26°C. to +30°C.)	10W-40
Above -5°F. (-21°C.)	15W-40
-5°F. to +75°F. (-21°C. to +24°C.)	15W-30

*This viscosity can be used at colder temperatures with engine oil preheating.

NOTE: *Crankcase oil should be MIL-L2104B/MIL-L2104C or have properties of API classification CC/CD grades.*

Hydraulic Oil

Table 1-3. Hydraulic Oil

HYDRAULIC SYSTEM OPERATING TEMPERATURE RANGE	SAE VISCOSITY GRADE
+0° to +180° F (-18° C to +83° C)	10W
+0° F to +210° F (-18° C to +99° C)	10W-20, 10W-30
+50° F to +210° F (+10° C to +210° C)	20W-20

NOTE: *Hydraulic oils must have anti-wear qualities at least to API Service Classification GL-3, and sufficient chemical stability for mobile hydraulic system service. JLG Industries recommends Mobilfluid 424 hydraulic oil, which has an SAE viscosity index of 152.*

NOTE: *When temperatures remain below 20° F (-7 degrees C), JLG Industries recommends the use of Mobil DTE 13M.*

Table 1-4. Mobil DTE 13M Specs

ISO Viscosity Grade	#32
Specific Gravity	0.877
Pour Point, Max	-40 F (-40 C)
Flash Point, Min.	330 F (166 C)
Viscosity	
at 40° C	33cSt
at 100° C	6.6 cSt
at 100° F	169 SUS
at 210° F	48 SUS
cp at -20° F	6,200
Viscosity Index	140

NOTE: *Aside from JLG recommendations, it is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities. If use of hydraulic oil other than Mobilfluid 424 is desired, contact JLG Industries for proper recommendations.*

Lubrication Specifications

Table 1-5. Lubrication Specifications

KEY	SPECIFICATIONS
MPG	Multipurpose Grease having a minimum dripping point of 350° F. Excellent water resistance and adhesive qualities, and being of extreme pressure type. (Timken OK 40 pounds minimum.)
EPGL	Extreme Pressure Gear Lube (oil) meeting API service classification GL-5 or MIL-Spec MIL-L-2105
HO	Hydraulic Oil. API service classification GL-3, e.g. Mobilfluid 424.
EO	Engine (crankcase) Oil. Gas - API SF, SH, SG class, MIL-L-2104. Diesel - API CC/CD class, MIL-L-2104B/MIL-L-2104C.

NOTE: *Refer to Lubrication Chart, for specific lubrication procedures.*

1.7 PRESSURE SETTINGS

Rexroth Valve

Main Relief - 3000 PSI (206.85 Bar).

Upper Boom Lift Down - 1500 PSI (103.4 Bar).

Swing - 1700 PSI (117.2 Bar).

Steer - 1800 PSI (124.11 Bar).

Steer Reliefs - 4WS Front & Rear - 1500 PSI (103.4 Bar).

Platform Level Forward - 2800 PSI (193.06 Bar).

Backward - 1800 PSI (124.11 Bar).

1.8 CYLINDER SPECIFICATIONS

Table 1-6. Cylinder Specifications

DESCRIPTON	BORE	STROKE	ROD DIA.
Lift	6.00 (152.4)	44.6875 (1135.1)	3 (76.2)
Telescope	3.5 (88.9)	177.75 (4514.9)	2.5 (63.5)
Steer	2.5 (63.5)	10.75 (273.1)	1.25 (31.8)
Lockout (2wd)	4 (101.6)	3.875 (98.4)	1.5 (38.1)
Master	3 (76.2)	8.5 (215.9)	1.5 (38.1)
Slave Level	3 (76.2)	8.5 (215.9)	1.5 (38.1)

1.9 MAJOR COMPONENT WEIGHTS

Table 1-7. Major Component Weights

Component	LB.	KG.
Platform Control Console	250	113
Platform Level Cylinder	46	21
Main Boom (Includes Lift Cyl., Rotator, and Support)	3527	1600
Turntable Complete (including engine)	7315	3318
Chassis Complete (w/pneumatic tires)	10400	4718
Chassis Complete (w/foam-filled tires)	11680	5300
Machine Complete (GVW) - 2WD w/pneumatic tires	22000	9979
Machine Complete (GVW) - 4WD w/pneumatic tires	22510	10211

1.10 CRITICAL STABILITY WEIGHTS

⚠ WARNING

DO NOT REPLACE ITEMS CRITICAL TO STABILITY WITH ITEMS OF DIFFERENT WEIGHT OR SPECIFICATION (FOR EXAMPLE: BATTERIES, FILLED TIRES, COUNTERWEIGHT, ENGINE & PLATFORM) DO NOT MODIFY UNIT IN ANY WAY TO AFFECT STABILITY.

Table 1-8. Critical Stability Weights

Component		LB.	KG.
Tire and Wheel (Foam Filled)	Size (14 - 17.5)	436	198
Tire and Wheel (Pneumatic))	Size (14 - 17.5)	165	75
Engine	Ford	460	209
	Deutz	534	242
	Continental	558	253
Counterweight	Weight	2900	1315
Platform	6 ft. (1.83 M)	205	93
	8 ft. (2.44 M)	230	105

1.11 SERIAL NUMBER LOCATIONS

A serial number plate is affixed to the left rear side of the frame. If the serial number plate is damaged or missing, the machine serial number is stamped on the left side of the frame.

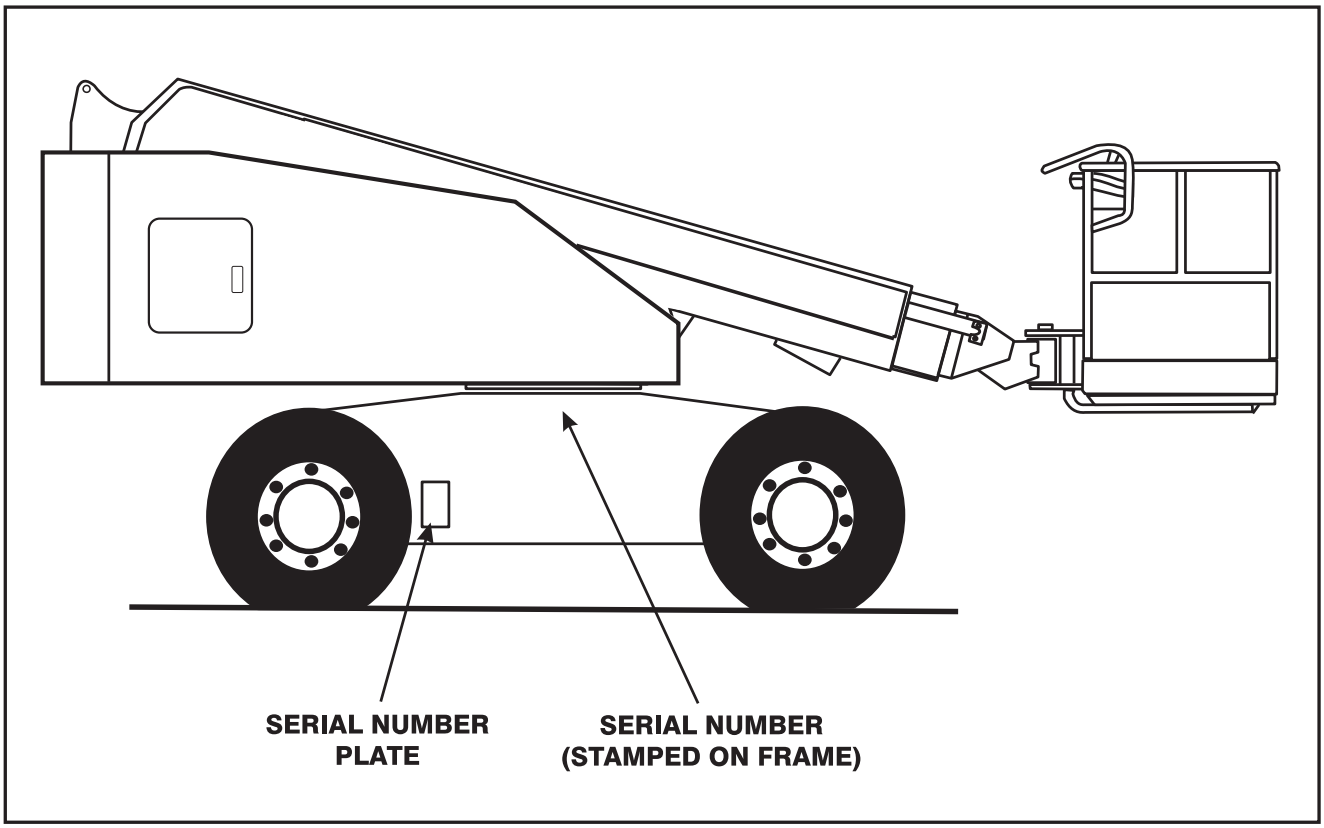

Figure 1-1. Serial Number Locations

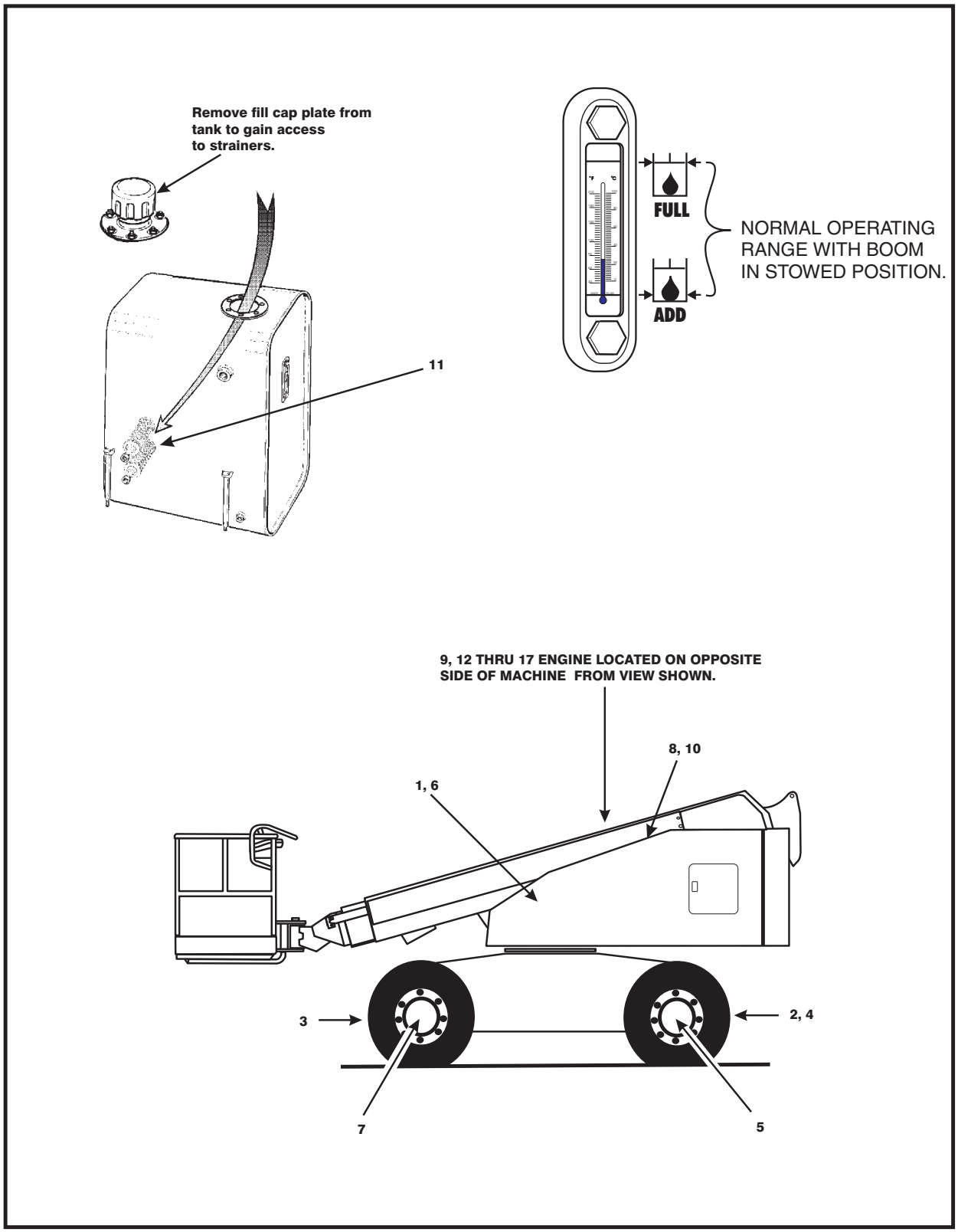

Figure 1-2. Lubrication Diagram

Table 1-9. Lubrication Chart

	Components	Number/Type Lube Points	Capacity	Lube	Interval		Hours		Comments
					3 Months 150 hrs	6 Months 300 hrs	1 Year 600 hrs	2 Years 1200 hrs	
Lubrication									
1	Swing Bearing	2 Grease Fittings	A/R	MPG	X				Remote Access
2	Steer Spindles (2WS)	8 Grease Fittings	A/R	MPG	X				
3	Steer Spindles (4WS)	2 Grease Fittings	A/R	MPG	X				
4	Steer Spindles (4WD)	4 Grease Fittings	A/R	MPG	X				
5	Wheel Bearings	Repack	A/R	MPG				X	
6	Swing Drive Hub	Level/Fill Plug	17 oz. (1/2 Full)	EPGL				X	Check level every 150 hrs/change 1200 hours
7	Wheel Drive Hub	Level/Fill Plug	17 oz. (1/2 Full)	EPGL				X	Check level every 150 hrs/change 1200 hours
8	Hydraulic Return Filter	N/A	N/A	N/A		X			Change after first 50 hrs. and every 300 hrs. thereafter or as indicated by Condition Indicator.
9	Hydraulic Charge Filter	N/A	N/A	N/A		X			Change after first 50 hrs. and every 300 hrs. thereafter or as indicated by Condition Indicator.
10	Hydraulic Oil	Fill Cap	30.6 gal. Tank 32.7 gal. System	HO				X	Check level daily/change 1200 hours
11	Suction Strainers (in tank)	2	N/A	N/A				X	Remove and clean at time of hydraulic oil change.
Engines									
12	Oil Change w/Filter - Ford LRG425	Fill Cap/Spin-on Element	4.5 Quarts	EO	X				Check level daily/change 150 hrs.
13	Oil Change w/Filter - Deutz	Fill Cap/Spin-on Element	6.3 Quarts Crankcase *5 Quarts Cooler	EO			X		Check level daily/change 1000 hrs. or one year, whichever comes first. Adjust final oil level by mark on dipstick.
14	Fuel Filter - Ford	Replaceable Element	N/A	N/A			X		
15	Fuel Filter - Deutz	Replaceable Element	N/A	N/A			X		
16	Air Filter - Ford	Replaceable Element	N/A	N/A		X			Or as indicated by Condition Indicator.
17	Air Filter - Deutz	Replaceable Element	N/A	N/A		X			Or as indicated by Condition Indicator.

NOTES:

Lubrication intervals are based on machine operation under normal conditions. For machines used in multi shift operations and/or exposed to hostile environments or conditions, lubrication frequencies must be increased accordingly.

** When changing oil in the Deutz oil cooled engine, drain both the crankcase and the cooler. When refilling it is acceptable to overfill the crankcase (11.3 qts., capacity of both crankcase and cooler combined). Start engine, allow the engine to run until the thermostat opens (approximately 221 degrees F) cooler will fill up within minutes; shut down and wait for approximately two minutes. Check oil level, fill oil to max marking on the dipstick.

KEY TO LUBRICANTS

EO	Engine Oil
EPGL	Extreme Pressure Gear Lube
HO	Hydraulic Fluid (Mobil #424 or equivalent)
MPG	Multi-Purpose Grease

VALUES FOR ZINC PLATED BOLTS ONLY														UNPLATED CAP SCREWS	
SIZE	THD	BOLT DIA. (IN.)	THREAD STRESS AREA (SQ. IN.)	SAE GRADE 5 BOLTS & GRADE 2 NUTS					SAE GRADE 8 BOLTS & GRADE 8 NUTS					UNBRAKO 1960 SERIES SOCKET HEAD CAP SCREW WITH LOC-WEL PATCH	
				CLAMP LOAD (LB.)	TORQUE				CLAMP LOAD (LB.)	TORQUE				CLAMP LOAD (LB.)	TORQUE (as received)
					(DRY OR LOC. 263)	(LUB.)	(LOCTITE 262)	(LOCTITE 242 OR 271)		(DRY OR LOC. 263)	(LUB.)	(LOCTITE 262)	(LOCTITE 242 OR 271)		
					LB. IN.	LB. IN.	LB. IN.	LB. IN.		LB. IN.	LB. IN.	LB. IN.	LB. IN.		LB. FT.
4	40	0.1120	0.00604	380	8	6	—	—	540	12	9	—	—	—	—
	48		0.00661	420	9	7	—	—	600	13	10	—	—	—	—
6	32	0.1380	0.00909	580	16	12	—	—	820	23	17	—	—	—	—
	40		0.01015	610	18	13	—	—	920	25	19	—	—	—	—
8	32	0.1640	0.01400	900	30	22	—	—	1260	41	31	—	—	—	—
	36		0.01474	940	31	23	—	—	1320	43	32	—	—	—	—
10	24	0.1900	0.01750	1120	43	32	—	—	1580	60	45	—	—	—	—
	32		0.02000	1285	49	36	—	—	1800	68	51	—	—	—	—
1/4	20	0.2500	0.0318	2020	96	75	—	105	2860	144	108	—	160	3180	13
	28		0.0364	2320	120	86	—	135	3280	168	120	—	185	3640	14
					LB. FT.	LB. FT.	LB. FT.	LB. FT.		LB. FT.	LB. FT.	LB. FT.	LB. FT.		
5/16	18	0.3125	0.0524	3340	17	13	16	19	4720	25	18	22	30	5240	25
	24		0.0580	3700	19	14	17	21	5220	25	20	25	30	5800	27
3/8	16	0.3750	0.0775	4940	30	23	28	35	7000	45	35	40	50	7750	45
	24		0.0878	5600	35	25	32	40	7900	50	35	45	55	8780	50
7/16	14	0.4375	0.1063	6800	50	35	45	55	9550	70	55	63	80	10630	70
	20		0.1187	7550	55	40	50	60	10700	80	60	70	90	11870	75
1/2	13	0.5000	0.1419	9050	75	55	68	85	12750	110	80	96	120	14190	110
	20		0.1599	10700	90	65	80	100	14400	120	90	108	135	15990	115
9/16	12	0.5625	0.1820	11600	110	80	98	120	16400	150	110	139	165	18200	155
	18		0.2030	12950	120	90	109	135	18250	170	130	154	190	20300	165
5/8	11	0.6250	0.2260	14400	150	110	135	165	20350	220	170	180	240	22600	210
	18		0.2560	16300	170	130	153	190	23000	240	180	204	265	25600	220
3/4	10	0.7500	0.3340	21300	260	200	240	285	30100	380	280	301	420	33400	365
	16		0.3730	23800	300	220	268	330	33600	420	320	336	465	37300	400
7/8	9	0.8750	0.4620	29400	430	320	386	475	41600	600	460	485	660	46200	585
	14		0.5090	32400	470	350	425	520	45800	660	500	534	725	50900	635
1	8	1.000	0.6060	38600	640	480	579	675	51500	900	680	687	990	60600	865
	12		0.6630	42200	700	530	633	735	59700	1000	740	796	1100	66300	915
1-1/8	7	1.1250	0.7630	42300	800	600	714	840	68700	1280	960	1030	1400	76300	1240
	12		0.8560	47500	880	660	802	925	77000	1440	1080	1155	1575	85600	1380
1-1/4	7	1.2500	0.9690	53800	1120	840	1009	1175	87200	1820	1360	1453	2000	96900	1750
	12		1.0730	59600	1240	920	1118	1300	96600	2000	1500	1610	2200	107300	1880
1-1/2	6	1.500	1.1550	64100	1460	1100	1322	1525	104000	2380	1780	1907	2625	115500	2320
	12		1.3150	73000	1680	1260	1506	1750	118100	2720	2040	2165	3000	131500	2440
1-1/2	6	1.500	1.4050	78000	1940	1460	1755	2025	126500	3160	2360	2530	3475	140500	3040
	12		1.5800	87700	2200	1640	1974	2300	142200	3560	2660	2844	3925	158000	3270

Note: These torque values do not apply to cadium plated fasteners.

SAE GRADE 5

SAE GRADE 8

Figure 1-3. Torque Chart

SECTION 2. GENERAL

2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

General

This section provides the necessary information needed by those personnel that are responsible to place the machine in operation readiness and maintain its safe operating condition. For maximum service life and safe operation, ensure that all the necessary inspections and maintenance have been completed before placing the machine into service.

Preparation, Inspection, and Maintenance

It is important to establish and conform to a comprehensive inspection and preventive maintenance program. The following table outlines the periodic machine inspections and maintenance recommended by JLG Industries, Inc. Consult your national, regional, or local regulations for further requirements for aerial work platforms. The frequency of inspections and maintenance must be increased as environment, severity and frequency of usage requires.

Pre-Start Inspection

It is the User's or Operator's primary responsibility to perform a Pre-Start Inspection of the machine prior to use daily or at each change of operator. Reference the Operator's and Safety Manual for completion procedures for the Pre-Start Inspection. The Operator and Safety Manual must be read in its entirety and understood prior to performing the Pre-Start Inspection.

Pre-Delivery Inspection and Frequent Inspection

The Pre-Delivery Inspection and Frequent Inspection shall be performed by a qualified JLG equipment mechanic. JLG Industries, Inc. recognizes a qualified JLG equipment mechanic as a person who, by possession of a recognized degree, certificate, extensive knowledge, training, or experience, has successfully demonstrated the ability and proficiency to service, repair, and maintain the subject JLG product model.

The Pre-Delivery Inspection and Frequent Inspection procedures are performed in the same manner, but at different times. The Pre-Delivery Inspection shall be performed prior to each sale, lease, or rental delivery. The Frequent Inspection shall be accomplished for each machine in service for 3 months or 150 hours (whichever comes first); out of service for a period of more than 3 months; or when purchased used. The frequency of this inspection must be increased as environment, severity and frequency of usage requires.

Reference the JLG Pre-Delivery and Frequent Inspection Form and the Inspection and Preventative Maintenance Schedule for items requiring inspection during the performance of these inspections. Reference the appropriate areas of this manual for servicing and maintenance procedures.

Annual Machine Inspection

The Annual Machine Inspection must be performed by a Factory-Certified Service Technician on an annual basis, no later than thirteen (13) months from the date of the prior Annual Machine Inspection. JLG Industries, Inc. recognizes a Factory-Certified Service Technician as a person who has successfully completed the JLG Service Training School for the subject JLG product model. Reference the machine Service and Maintenance Manual and appropriate JLG inspection form for performance of this inspection.

Reference the JLG Annual Machine Inspection Form and the Inspection and Preventative Maintenance Schedule for items requiring inspection during the performance of this inspection. Reference the appropriate areas of this manual for servicing and maintenance procedures.

For the purpose of receiving safety-related bulletins, it is important that JLG Industries, Inc. has updated ownership information for each machine. When performing each Annual Machine Inspection, notify JLG Industries, Inc. of the current machine ownership.

Preventative Maintenance

In conjunction with the specified inspections, maintenance shall be performed by a qualified JLG equipment mechanic. JLG Industries, Inc. recognizes a qualified JLG equipment mechanic as a person who, by possession of a recognized degree, certificate, extensive knowledge, training, or experience, has successfully demonstrated the ability and proficiency to service, repair, and maintain the subject JLG product model.

Reference the Preventative Maintenance Schedule and the appropriate areas of this manual for servicing and maintenance procedures. The frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.

Table 2-1. Inspection and Maintenance

Type	Frequency	Primary Responsibility	Service Qualification	Reference
Pre-Start Inspection	Prior to use each day; or At each Operator change.	User or Operator	User or Operator	Operator and Safety Manual
Pre-Delivery Inspection	Prior to each sale, lease, or rental delivery.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Frequent Inspection	In service for 3 months or 150 hours, whichever comes first; or Out of service for a period of more than 3 months; or Purchased used.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Annual Machine Inspection	Annually, no later than 13 months from the date of the prior inspection.	Owner, Dealer, or User	Factory-Certified Service Technician	Service and Maintenance Manual and applicable JLG inspection form.
Preventative Maintenance	At intervals as specified in the Service and Maintenance Manual.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual

2.2 SERVICE AND GUIDELINES

General

The following information is provided to assist you in the use and application of servicing and maintenance procedures contained in this book.

Safety and Workmanship

Your safety, and that of others, is the first consideration when engaging in the maintenance of equipment. Always be conscious of weight. Never attempt to move heavy parts without the aid of a mechanical device. Do not allow heavy objects to rest in an unstable position. When raising a portion of the equipment, ensure that adequate support is provided.

Cleanliness

1. The most important single item in preserving the long service life of a machine is to keep dirt and foreign materials out of the vital components. Precautions have been taken to safeguard against this. Shields, covers, seals, and filters are provided to keep air, fuel, and oil supplies clean; however, these items must be maintained on a scheduled basis in order to function properly.
2. At any time when air, fuel, or oil lines are disconnected, clear adjacent areas as well as the openings and fittings themselves. As soon as a line or component is disconnected, cap or cover all openings to prevent entry of foreign matter.
3. Clean and inspect all parts during servicing or maintenance, and assure that all passages and openings are unobstructed. Cover all parts to keep them clean. Be sure all parts are clean before they are installed. New parts should remain in their containers until they are ready to be used.

Components Removal and Installation

1. Use adjustable lifting devices, whenever possible, if mechanical assistance is required. All slings (chains, cables, etc.) should be parallel to each other and as near perpendicular as possible to top of part being lifted.
2. Should it be necessary to remove a component on an angle, keep in mind that the capacity of an eyebolt or similar bracket lessens, as the angle between the supporting structure and the component becomes less than 90 degrees.
3. If a part resists removal, check to see whether all nuts, bolts, cables, brackets, wiring, etc., have been removed and that no adjacent parts are interfering.

Component Disassembly and Reassembly

When disassembling or reassembling a component, complete the procedural steps in sequence. Do not partially disassemble or assemble one part, then start on another. Always recheck your work to assure that nothing has been overlooked. Do not make any adjustments, other than those recommended, without obtaining proper approval.

Pressure-Fit Parts

When assembling pressure-fit parts, use an anti-seize or molybdenum disulfide base compound to lubricate the mating surface.

Bearings

1. When a bearing is removed, cover it to keep out dirt and abrasives. Clean bearings in nonflammable cleaning solvent and allow to drip dry. Compressed air can be used but do not spin the bearing.
2. Discard bearings if the races and balls (or rollers) are pitted, scored, or burned.
3. If bearing is found to be serviceable, apply a light coat of oil and wrap it in clean (waxed) paper. Do not unwrap reusable or new bearings until they are ready to install.
4. Lubricate new or used serviceable bearings before installation. When pressing a bearing into a retainer or bore, apply pressure to the outer race. If the bearing is to be installed on a shaft, apply pressure to the inner race.

Gaskets

Check that holes in gaskets align with openings in the mating parts. If it becomes necessary to hand-fabricate a gasket, use gasket material or stock of equivalent material and thickness. Be sure to cut holes in the right location, as blank gaskets can cause serious system damage.

Bolt Usage and Torque Application

1. Use bolts of proper length. A bolt which is too long will bottom before the head is tight against its related part. If a bolt is too short, there will not be enough thread area to engage and hold the part properly. When replacing bolts, use only those having the same specifications of the original, or one which is equivalent.
2. Unless specific torque requirements are given within the text, standard torque values should be used on heat-treated bolts, studs, and steel nuts, in accordance with recommended shop practices. (See Torque Chart Section 1.)

Hydraulic Lines and Electrical Wiring

Clearly mark or tag hydraulic lines and electrical wiring, as well as their receptacles, when disconnecting or removing them from the unit. This will assure that they are correctly reinstalled.

Hydraulic System

1. Keep the system clean. If evidence of metal or rubber particles are found in the hydraulic system, drain and flush the entire system.
2. Disassemble and reassemble parts on clean work surface. Clean all metal parts with non-flammable cleaning solvent. Lubricate components, as required, to aid assembly.

Lubrication

Service applicable components with the amount, type, and grade of lubricant recommended in this manual, at the specified intervals. When recommended lubricants are not available, consult your local supplier for an equivalent that meets or exceeds the specifications listed.

Battery

Clean battery, using a non-metallic brush and a solution of baking soda and water. Rinse with clean water. After cleaning, thoroughly dry battery and coat terminals with an anti corrosion compound.

Lubrication and Servicing

Components and assemblies requiring lubrication and servicing are shown in the Lubrication Chart in Section 1.

2.3 LUBRICATION AND INFORMATION

Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants enter the system by various means, e.g., using inadequate hydraulic oil, allowing moisture, grease, filings, sealing components, sand, etc., to enter when performing maintenance, or by permitting the pump to cavitate due to insufficient system warm-up or leaks in the pump supply (suction) lines.

2. The design and manufacturing tolerances of the component working parts are very close, therefore, even the smallest amount of dirt or foreign matter entering a system can cause wear or damage to the components and generally results in faulty operation. Every precaution must be taken to keep hydraulic oil clean, including reserve oil in storage. Hydraulic system filters should be checked, cleaned, and/or replaced as necessary, at the specified intervals required in the Lubrication Chart in Section 1. Always examine filters for evidence of metal particles.

3. Cloudy oils indicate a high moisture content which permits organic growth, resulting in oxidation or corrosion. If this condition occurs, the system must be drained, flushed, and refilled with clean oil.

4. It is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities. Good grade mineral oils, with viscosities suited to the ambient temperatures in which the machine is operating, are recommended for use.

NOTE: *Metal particles may appear in the oil or filters of new machines due to the wear-in of meshing components.*

Hydraulic Oil

1. Refer to Section 1 for recommendations for viscosity ranges.

2. JLG recommends Mobilfluid 424 hydraulic oil, which has an SAE viscosity of 10W-30 and a viscosity index of 152.

NOTE: *Start-up of hydraulic system with oil temperatures below -15 degrees F (-26 degrees C) is not recommended. If it is necessary to start the system in a sub-zero environment, it will be necessary to heat the oil with a low density, 100VAC heater to a minimum temperature of -15 degrees F (-26 degrees C).*

3. The only exception to the above is to drain and fill the system with Mobil DTE 13 oil or its equivalent. This will allow start up at temperatures down to -20 degrees F (-29 degrees C). However, use of this oil will give poor performance at temperatures above 120 degrees F (49 degrees C). Systems using DTE 13 oil should not be operated at temperatures above 200 degrees F (94 degrees C) under any condition.

Changing Hydraulic Oil

1. Use of any of the recommended crankcase or hydraulic oils eliminates the need for changing the oil on a regular basis. However, filter elements must be changed after the first 50 hours of operation and every 300 hours thereafter. If it is necessary to change the oil, use only those oils meeting or exceeding the specifications appearing in this manual. If unable to obtain the same type of oil supplied with the machine, consult local supplier for assistance in selecting the proper equivalent. Avoid mixing petroleum and synthetic base oils. JLG Industries recommends changing the hydraulic oil annually.

2. Use every precaution to keep the hydraulic oil clean. If the oil must be poured from the original container into another, be sure to clean all possible contaminants from the service container. Always clean the mesh element of the filter and replace the cartridge any time the system oil is changed.

3. While the unit is shut down, a good preventive maintenance measure is to make a thorough inspection of all hydraulic components, lines, fittings, etc., as well as a functional check of each system, before placing the machine back in service.

Lubrication Specifications

Specified lubricants, as recommended by the component manufacturers, are always the best choice, however, multi-purpose greases usually have the qualities which meet a variety of single purpose grease requirements. Should any question arise, regarding the use of greases in maintenance stock, consult your local supplier for evaluation. Refer to Section 1 for an explanation of the lubricant key designations appearing in the Lubrication Chart.

2.4 CYLINDER DRIFT TEST

Maximum acceptable cylinder drift is to be measured using the following methods.

Platform Drift

Measure the drift of the platform to the ground. Lower booms (if equipped) slightly elevated, upper boom fully extended with the rated load in the platform and power off. Maximum allowable drift is 2 inches (5 cm) in 10 minutes. If the machine does not pass this test, proceed with the following.

Cylinder Drift

Table 2-2. Cylinder Drift

Cylinder Bore Diameter		Max. Acceptable Drift in 10 Minutes	
inches	mm	inches	mm
3	76.2	0.026	0.66
3.5	89	0.019	0.48
4	101.6	0.015	0.38
5	127	0.009	0.22
6	152.4	0.006	0.15
7	177.8	0.005	0.13

Drift is to be measured at the cylinder rod with a calibrated dial indicator. The cylinder oil must be at ambient temperature and temperature stabilized.

The cylinder must have the normal load, which is the normal platform load applied.

If the cylinder passes this test, it is acceptable.

NOTE: *This information is based on 6 drops per minute cylinder leakage.*

2.5 PINS AND COMPOSITE BEARING REPAIR GUIDELINES

Filament wound bearings.

1. Pinned joints should be disassembled and inspected if the following occurs:
   a. Excessive sloppiness in joints.
   b. Noise originating from the joint during operation.
2. Filament wound bearings should be replaced if any of the following is observed:
   a. Frayed or separated fibers on the liner surface.
   b. Cracked or damaged liner backing.
   c. Bearings that have moved or spun in their housing.
   d. Debris embedded in liner surface.
3. Pins should be replaced if any of the following is observed (pin should be properly cleaned prior to inspection):
   a. Detectable wear in the bearing area.
   b. Flaking, pealing, scoring, or scratches on the pin surface.
   c. Rusting of the pin in the bearing area.
4. Re-assembly of pinned joints using filament wound bearings.
   a. Housing should be blown out to remove all dirt and debris...bearings and bearing housings must be free of all contamination.
   b. Bearing / pins should be cleaned with a solvent to remove all grease and oil...filament wound bearing are a dry joint and should not be lubricated.
   c. Pins should be inspected to ensure it is free of burrs, nicks, and scratches which would damage the bearing during installation and operation.

2.6 WELDING ON JLG EQUIPMENT

NOTE: *This instruction applies to repairs, or modifications to the machine and to welding performed from the machine on an external structure, or component,*

Do the Following When Welding on JLG Equipment

- Disconnect the battery.
- Disconnect the moment pin connection (where fitted)
- Ground only to structure being welded.

Do NOT Do the Following When Welding on JLG Equipment

- Ground on frame and weld on any other area than the chassis.
- Ground on turntable and weld on any other area than the turntable.
- Ground on the platform/support and weld on any other area than the platform/support.
- Ground on a specific boom section and weld on any other area than that specific boom section.
- Allow pins, wear pads, wire ropes, bearings, gearing, seals, valves, electrical wiring, or hoses to be between the grounding position and the welded area.

⚠ CAUTION

FAILURE TO COMPLY WITH THE ABOVE REQUIREMENTS MAY RESULT IN COMPONENT DAMAGE (I.E. ELECTRONIC MODULES, SWING BEARING, COLLECTOR RING, BOOM WIRE ROPES ETC.)

2.7 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

Silicone Dielectric Compound must be used on all electrical connections for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors. This procedure applies to all plug connections not enclosed in a box. Silicone grease should not be applied to connectors with external seals.

1. To prevent oxidation, silicone grease must be packed completely around male and female pins on the inside of the connector prior to assembly. This is most easily achieved by using a syringe.

NOTE: *Over a period of time, oxidation increases electrical resistance at the connection, eventually causing circuit failure.*

2. To prevent shorting, silicone grease must be packed around each wire where they enter the outside of the connector housing. Also, silicone grease must be applied at the joint where the male and female connectors come together. Any other joints (around strain reliefs, etc.) where water could enter the connector should also be sealed.

NOTE: *This condition is especially common when machines are pressure washed since the washing solution is much more conductive than water.*

3. Anderson connectors for the battery boxes and battery chargers should have silicone grease applied to the contacts only.

NOTE: *Curing-type sealants might also be used to prevent shorting and would be less messy, but would make future pin removal more difficult.*

2.8 AMP CONNECTOR

Applying Silicone Dielectric Compound to AMP Connectors

Silicone Dielectric Compound must be used on the AMP connections for the following reasons:

- To prevent oxidation at the mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors.

1. To prevent oxidation and low level conductivity, silicone dielectric grease must be packed completely around male and female pins on the inside of the connector after the mating of the housing to the header. This is easily achieved by using a syringe to fill the header with silicone dielectric compound, to a point just above the top of the male pins inside the header. When assembling the housing to the header, it is possible that the housing will become air locked, thus preventing the housing latch from engaging.
2. Pierce one of the unused wire seals to allow the trapped air inside the housing to escape.
3. Install a hole plug into this and/or any unused wire seal that has silicone dielectric compound escaping from it.

Assembly

Check to be sure the wedge lock is in the open, or as-shipped, position (See Figure 2-1.). Proceed as follows:

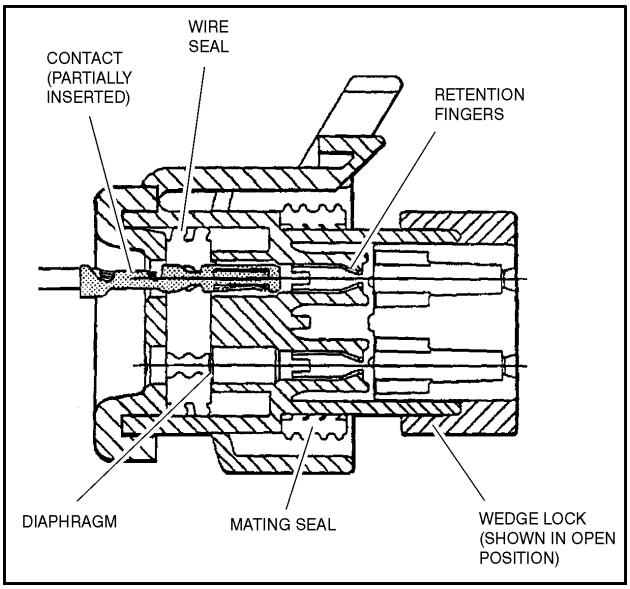

Figure 2-1. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 2-3.).
2. Pull back on the contact wire with a force of 1 or 2 lbs. to be sure the retention fingers are holding the contact (See Figure 2-3.).

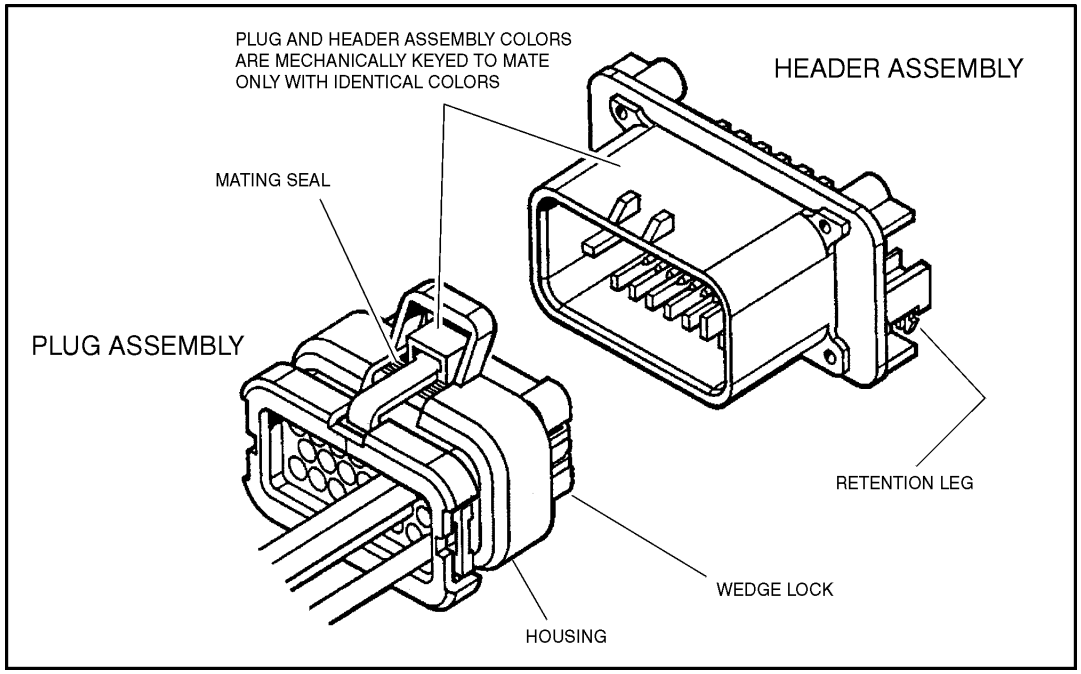

Figure 2-2. AMP Connector

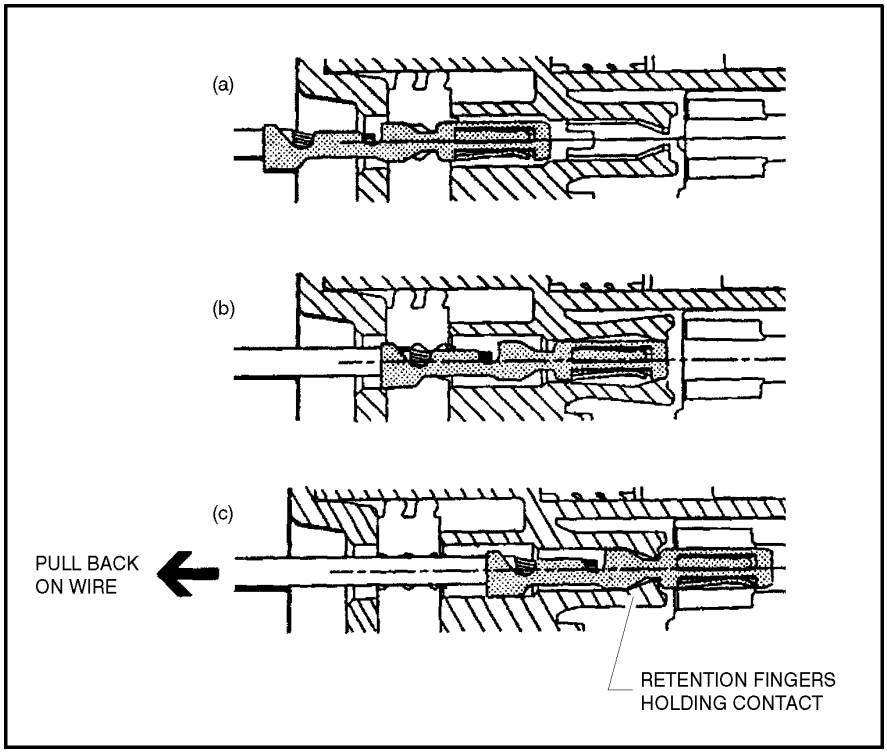

Figure 2-3. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position. Release the locking latches by squeezing them inward (See Figure 2-4.).

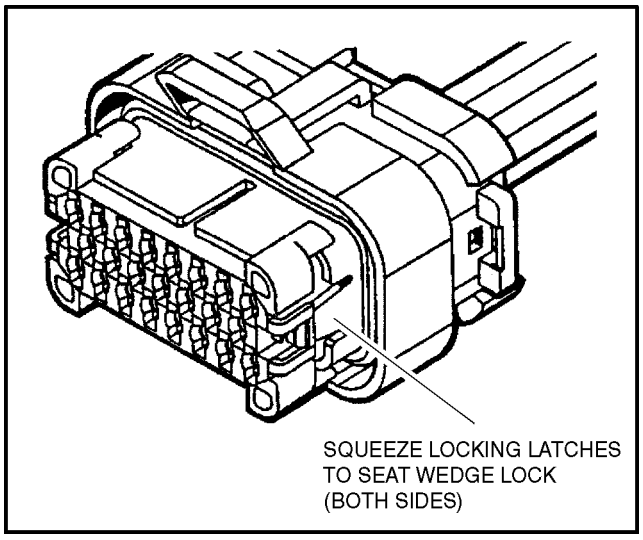

Figure 2-4. Connector Assembly Figure 3

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 2-5.).

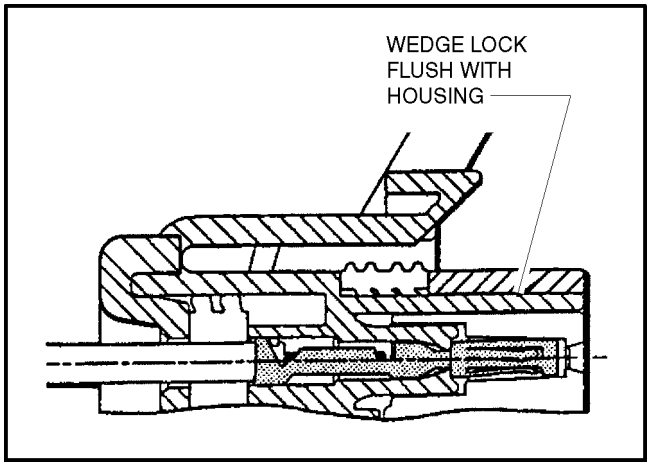

Figure 2-5. Connector Assembly Figure 4

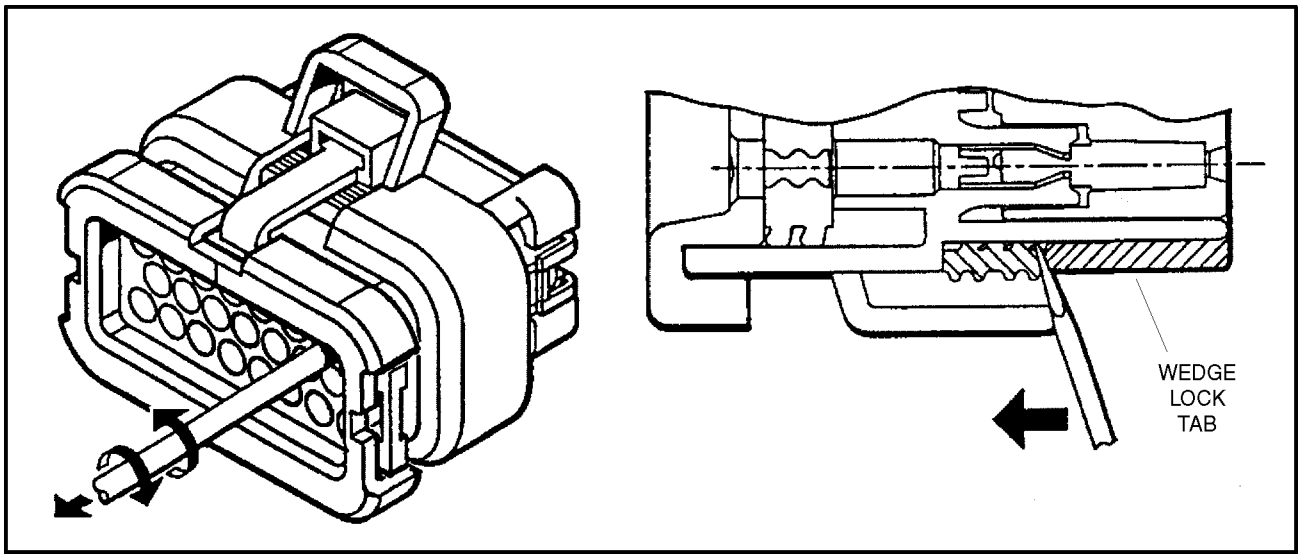

Figure 2-6. Connector Disassembly

Disassembly

1. Insert a 4.8 mm (3/16") wide screwdriver blade between the mating seal and one of the red wedge lock tabs.
2. Pry open the wedge lock to the open position.
3. While rotating the wire back and forth over a half turn (1/4 turn in each direction), gently pull the wire until the contact is removed.

NOTE: *The wedge lock should never be removed from the housing for insertion or removal of the contacts.*

Wedge Lock

The wedge lock has slotted openings in the forward, or mating end. These slots accommodate circuit testing in the field, by using a flat probe such as a pocket knife. DO NOT use a sharp point such as an ice pick.

Service - Voltage Reading

⚠ CAUTION

DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice should be discouraged when dealing with the AMPSEAL plug assembly, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and could result in system failure.

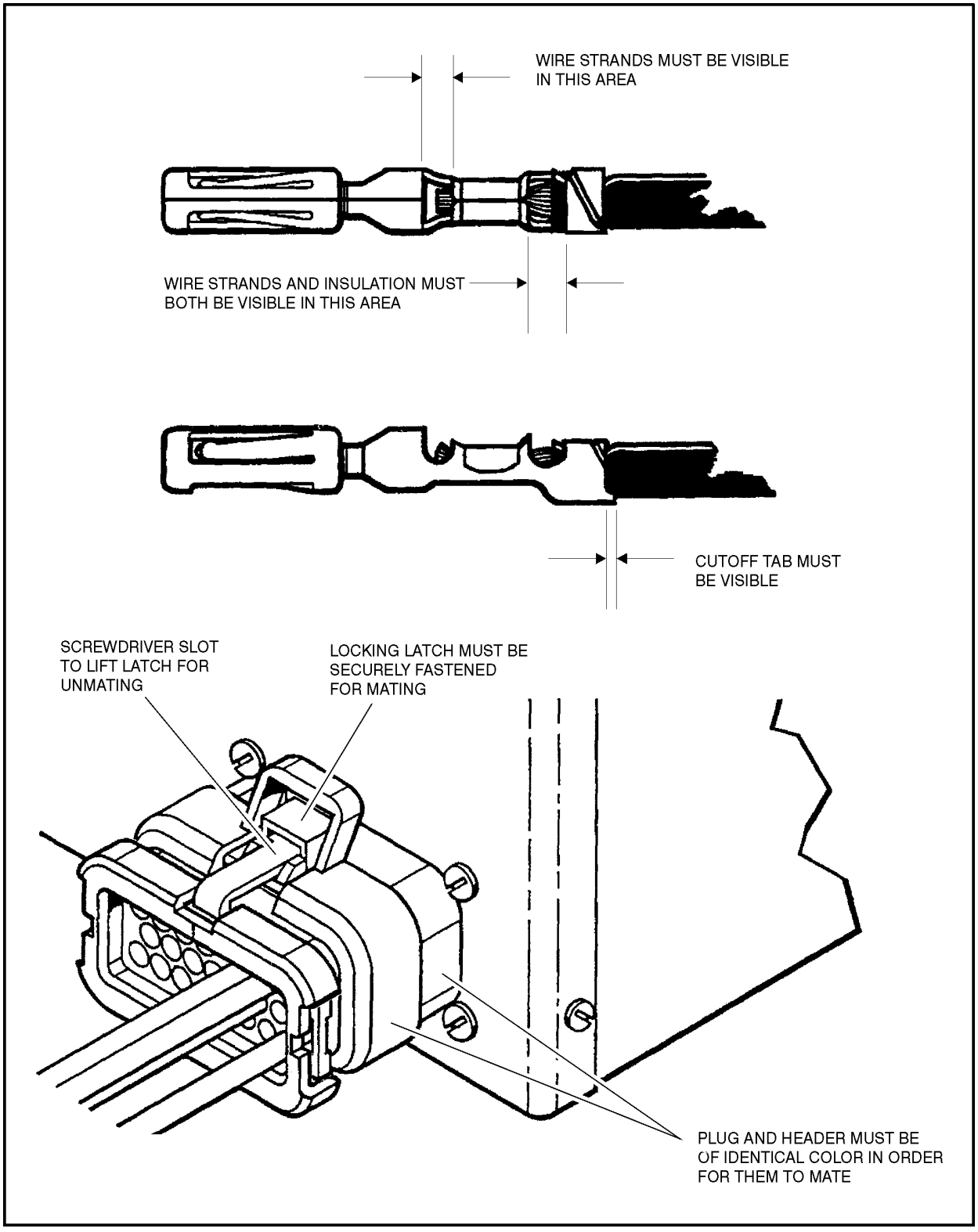

Figure 2-7. Connector Installation

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Boom Assembly	9					
Boom Weldments				1,2,4	1,2,4	
Hose/Cable Carrier Installations				1,2,9,12	1,2,9,12	
Pivot Pins and Pin Retainers				1,2	1,2	
Sheaves, Sheave Pins				1,2	1,2	
Bearings				1,2	1,2	
Wear Pads				1,2	1,2	
Covers or Shields				1,2	1,2	
Extend/Retract Chain or Cable Systems				1,2,3	1,2,3	
Platform Assembly	9					
Platform	1,2				1,2	
Railing	1,2			1	1,2	
Gate			5	1	1,5	
Floor	1,2			1	1,2	
Rotator		9,5				
Lanyard Anchorage Point	2			1,2,10	1,2,10	
Turntable Assembly	9					
Swing Bearing or Worm Gear				1,2,14	1,2,3,13,14	
Oil Coupling		9				
Swing Drive System						
Turntable Lock				1,2,5	1,2,5	
Hood, Hood Props, Hood Latches				5	1,2,5	
Chassis Assembly	9					
Tires	1	16,17		16,17,18	16,17,18	
Wheel Nuts/Bolts	1	15		15	15	
Wheel Bearings						14,24
Oscillating Axle/Lockout Cylinder Systems					5,8	
Outrigger or Extendable Axle Systems				5,8	5,8	
Steer Components						
Drive Motors						
Torque Hubs				11	11	
Functions/Controls	9					
Platform Controls	5	5		6	6	

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Ground Controls	5	5		6	6	
Function Control Locks, Guards, or Detents	1,5	1,5		5	5	
Footswitch	1,5			5	5	
Emergency Stop Switches (Ground & Platform)	5			5	5	
Function Limit or Cutout Switch Systems				5	5	
Capacity Indicator					5	
Drive Brakes				5		
Swing Brakes				5		
Boom Synchronization/Sequencing Systems					5	
Manual Descent or Auxiliary Power				5	5	
Power System	9					
Engine Idle, Throttle, and RPM				3	3	
Engine Fluids (Oil, Coolant, Fuel)	11	9,11		11	11	
Air/Fuel Filter		1,7		7	7	
Exhaust System			1,9	9	9	
Batteries	5	1,9			19	
Battery Fluid		11		11	11	
Battery Charger		5			5	
Fuel Reservoir, Cap, and Breather	11,9		2	1,5	1,5	
Hydraulic/Electric System	9					
Hydraulic Pumps		1,9		1,2,9		
Hydraulic Cylinders		1,9,7	2	1,2,9	1,2,9	
Cylinder Attachment Pins and Pin Retainers		1,9		1,2	1,2	
Hydraulic Hoses, Lines, and Fittings		1,9	12	1,2,9,12	1,2,9,12	
Hydraulic Reservoir, Cap, and Breather	11	1,9	2	1,5	1,5	24
Hydraulic Filter		1,9		7	7	
Hydraulic Fluid	11			7,11	7,11	
Electrical Connections		1		20	20	
Instruments, Gauges, Switches, Lights, Horn		1			5,23	
General						
Operators and Safety Manuals in Storage Box	21			21	21	
ANSI and EMI Manuals/Handbooks Installed					21	
Capacity Decals Installed, Secure, Legible	21			21	21	
All Decals/Placards Installed, Secure, Legible	21			21	21	

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Walk-Around Inspection Performed	21					
Annual Machine Inspection Due				21		
No Unauthorized Modifications or Additions				21	21	
All Relevant Safety Publications Incorporated				21	21	
General Structural Condition and Welds				2,4	2,4	
All Fasteners, Pins, Shields, and Covers				1,2	1,2	
Grease and Lubricate to Specifications				22	22	
Function Test of All Systems	21			21	21, 22	
Paint and Appearance				7	7	
Stamp Inspection Date on Frame					22	
Notify JLG of Machine Ownership					22	

Footnotes:

[1] Prior to use each day; or at each Operator change

[2] Prior to each sale, lease, or delivery

[3] In service for 3 months or 150 Hours; or Out of service for 3 months or more; or Purchased used

[4] Annually, no later than 13 months from the date of the prior inspection

Performance Codes:

1 - Check for proper and secure installation
2 - Visual inspection for damage, cracks, distortion or excessive wear
3 - Check for proper adjustment
4 - Check for cracked or broken welds
5 - Operates Properly
6 - Returns to neutral or "off" position when released
7 - Clean and free of debris
8 - Interlocks function properly
9 - Check for signs of leakage
10 - Decals installed and legible
11 - Check for proper fluid level
12 - Check for chafing and proper routing
13 - Check for proper tolerances
14 - Properly lubricated
15 - Torqued to proper specification
16 - No gouges, excessive wear, or cords showing
17 - Properly inflated and seated around rim
18 - Proper and authorized components
19 - Fully charged
20 - No loose connections, corrosion, or abrasions
21 - Verify
22 - Perform
23 - Sealed Properly
24 - Drain, Clean, Refill

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SECTION 3. CHASSIS & TURNTABLE

3.1 TORQUE HUB, DRIVE

Disassembly

1. Position hub over suitable container and remove drain plugs (10) from unit. Allow oil to completely drain, then replace drain plugs.
2. Remove eight bolts (41) and four shoulder bolts (42) securing cover assembly to hub (7). Remove cover assembly (23) and discard o-ring seal (22).
3. Lift carrier assembly and top thrust washer and thrust bearing (39, 40) from hub. Thrust washer may stick inside cover.
4. Pry ring gear (21) loose from hub and remove it. Remove o-ring seal (22) from hub counter bore and discard it.
5. Remove input gear (37) and thrust spacer (36) from input shaft assembly and remove input shaft assembly from hub.
6. Lift internal gear (12) and thrust washer and thrust bearing (39, 40) from hub. Thrust washer may stick to bottom of carrier.
7. Remove retaining ring (9) from spindle (1) and discard; lift hub from spindle.

⚠ CAUTION

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING REMOVAL.

8. Remove inside bearing cone (6) and bearing shim (8).
9. If necessary, pry seal (2) out of hub using screwdriver or pry bar. With seal removed, outside bearing cone (4) can be removed.
10. If necessary, remove inner and outer bearing cones (3, 5) using a suitable slide hammer puller.

⚠ IMPORTANT

WHEN REBUILDING TORQUE HUB, REMOVE AND REPLACE ALL O-RINGS AND RETAINING RINGS.

Cleaning and Inspection

1. Thoroughly clean all parts in an approved cleaning solvent.
2. Inspect bearing cups and cones for damage, pitting, corrosion, or excessive wear. If necessary, replace bearings as a complete set ensuring that they remain covered until use.
3. Inspect bearing mounting surfaces on spindle, hub, input shaft and carrier. Replace components as necessary.
4. Inspect all geared components for chipped or broken teeth and for excessive or uneven wear patterns.
5. Inspect carrier for damage, especially in anti-roll pin and planet shaft hole areas.
6. Inspect all planet shafts for scoring or other damage.
7. Inspect all threaded components for damage including stretching, thread deformation, or twisting.
8. Inspect seal mounting area in hub for burrs or sharp edges. Dress applicable surfaces or replace components as necessary.
9. Inspect cover for cracks or other damage, and o-ring sealing area for burrs or sharp edges. Dress applicable surfaces or replace cover as necessary.

Repair

1. Cover Assembly.
   a. Remove two bolts (25) securing disconnect cap (26) to cover (23) and remove cap.
   b. Remove two bolts (25) securing cover cap (24) to cover and remove cap.
   c. Remove disconnect rod (27) from cap and remove o-rings (28, 29) from cover cap. Discard o-rings.
   d. If necessary, remove pipe plug (30) from cover.
   e. Clean and inspect parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.
   f. If removed, screw pipe plug into cover.
   g. Slip o-ring (29) over cover cap and against face.
   h. Place o-ring (28) into cover cap internal groove. Disconnect rod may be used to push o-ring into groove.
   i. Place cover cap into cover with large hole located over pipe plug. Secure cover cap to cover with two bolts. Torque bolts to 70-80 in. lbs. (7.9-9.0 Nm).
   j. Place disconnect cap over cover cap with nipple facing out and secure with two bolts. Torque bolts to 70-80 in. lbs. (7.9-9.0 Nm).

k. Turn cover over and push disconnect rod into cover cap. Rod will be held in place by friction from o-ring.

2. Carrier Assembly.

a. Drive anti-roll pin (19) into planet shaft (17) using a suitable punch.

b. Using a suitable press, press planet shaft from carrier (13). After planet shaft is removed, drive anti-roll pin from shaft.

c. Remove cluster gear (18) and thrust washers (14) from carriers.

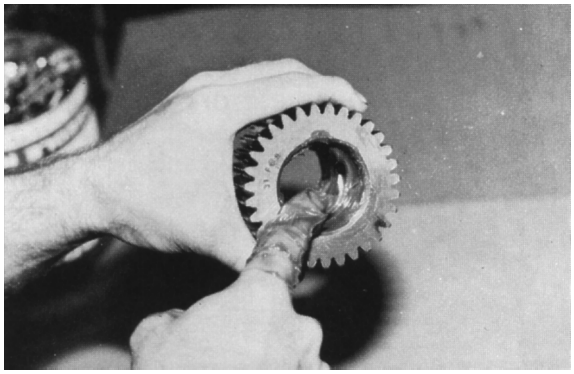
d. Remove sixteen needle rollers (15) from cluster gear bore.

e. Remove spacer (16) from cluster gear bore and remove second set of sixteen needle rollers (15).

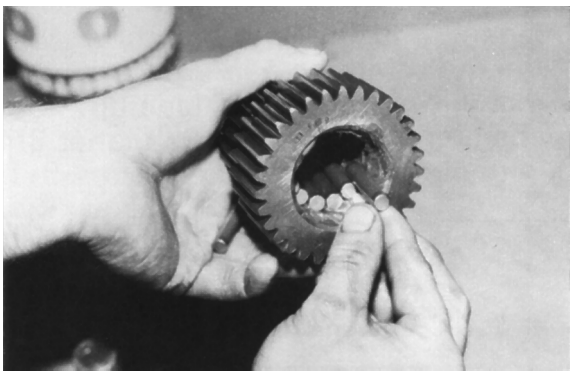
f. Repeat steps (a) through (e) for remaining two cluster gears.

g. Clean and inspect all parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.

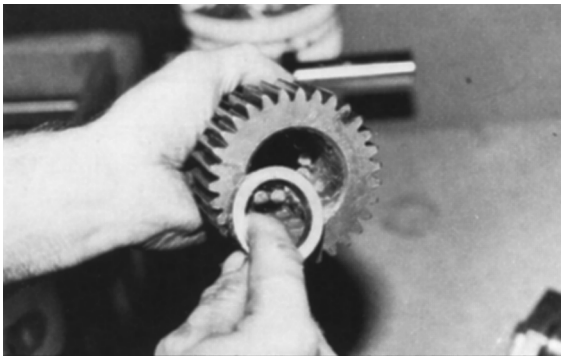
h. Apply a coat of grease or petroleum jelly to cluster gear bore.



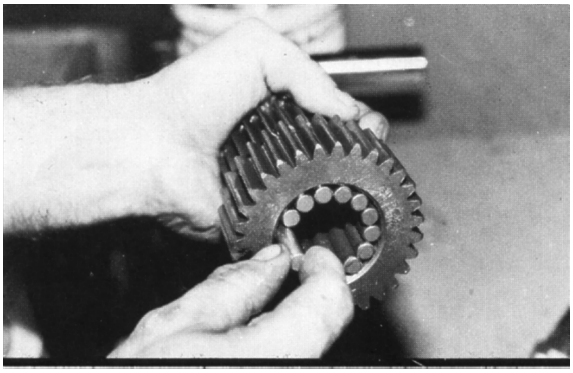
i. Place sixteen needle rollers into cluster gear bore.



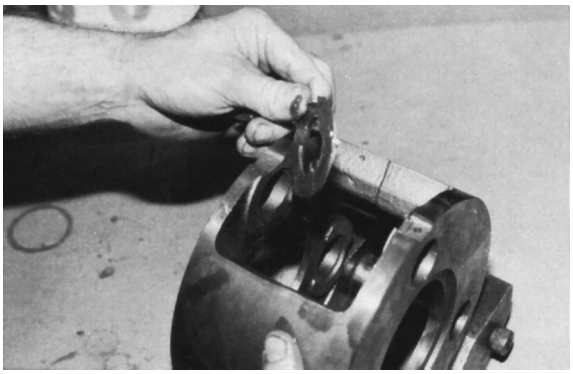
j. Place spacer into opposite side of cluster gear and against needle rollers.



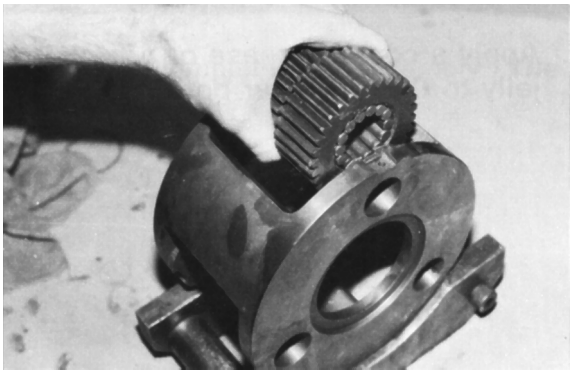
k. Place second set of sixteen needle rollers into cluster gear.



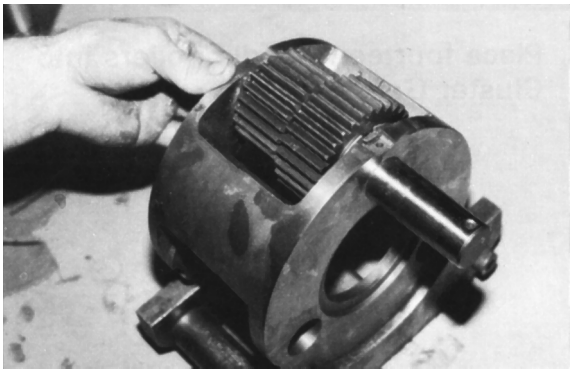
l. Apply grease or petroleum jelly to tang side of two thrust washers. Place thrust washers against bosses in carrier with washer tang fitting into slot in carrier outside diameter.



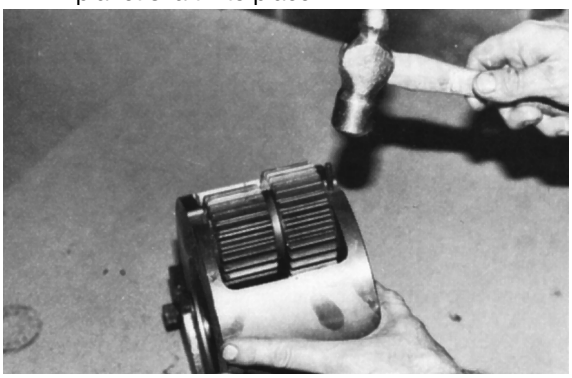
m. While keeping thrust washers in place, slide cluster gear into carrier with larger gear on side with small pin hole.



n. Line up cluster gear and thrust washers with hole in carrier and slide planet shaft through. Ensure chamfered side of hole in planet shaft is lined up with pin hole in carrier.



o. Drive anti-roll pin flush into carrier hole, locking planet shaft into place.



p. repeat steps (h) through (o) for remaining two cluster gears.

3. Input Shaft Assembly.

⚠ CAUTION

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING REMOVAL AND INSTALLATION

a. Carefully remove retaining ring (33) from counterbore in the spindle (1) and discard retaining ring.

b. Remove two spacers (31) and spring (32) from input shaft.

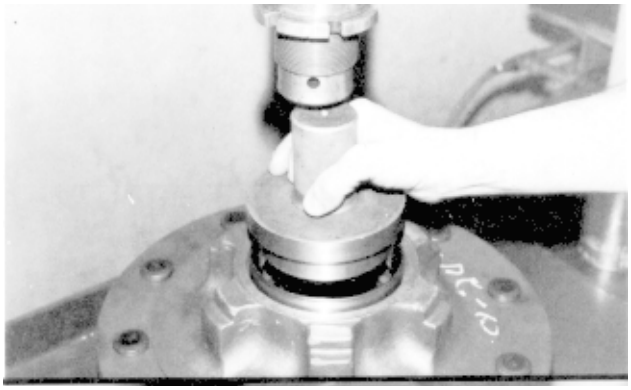
c. Clean and inspect all parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.

d. Place washer (31), spring (32), and washer (31), in that order, onto input shaft.

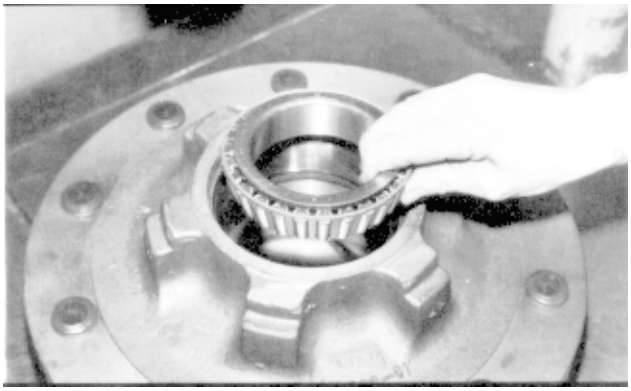
e. Install retaining ring into input shaft groove to secure spacers and spring to shaft.

Assembly

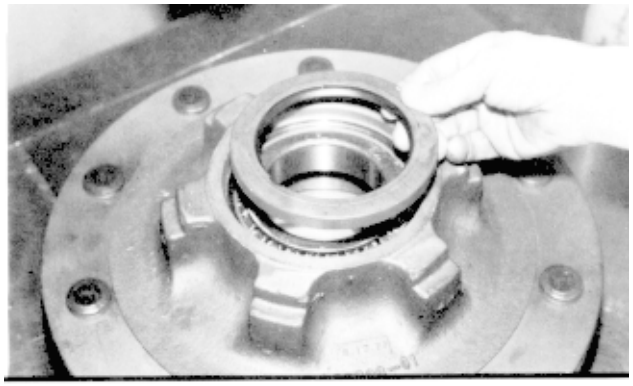
1. Using a suitable press, press new bearing cups (3, 5), with large inside diameters facing out, into hub (7) counter bores.



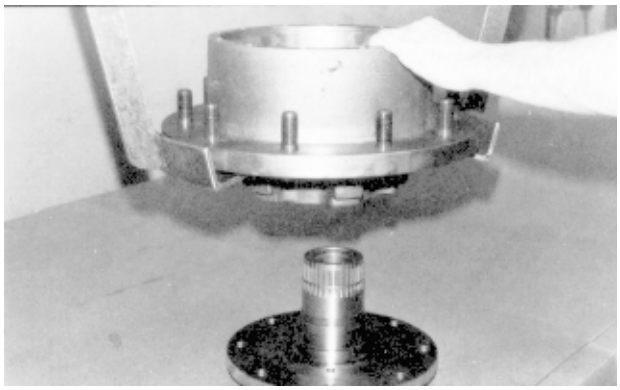
2. Place bearing cone (4) into bearing cup (3) in small end of hub.



3. Press new seal (2) into hub counter bore with flat metal side facing in. Use a flat object to ensure that seal is pressed evenly and is flush with hub face.

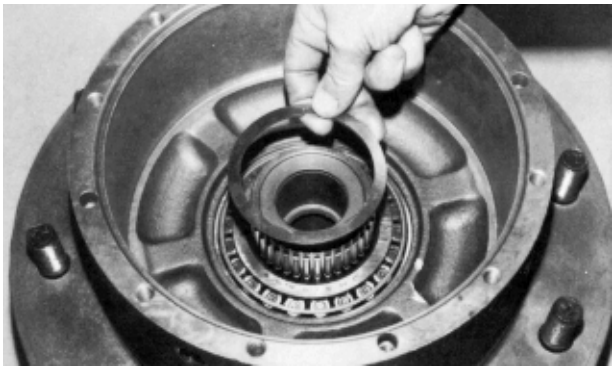


4. Lower hub onto spindle (1) with large open end up.



5. Place bearing cone (6) over end of spindle and into bearing cup.

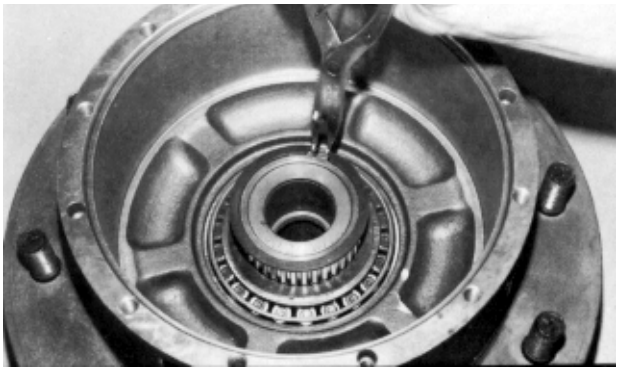
6. Place bearing shim (8) over end of spindle and against bearing cone.



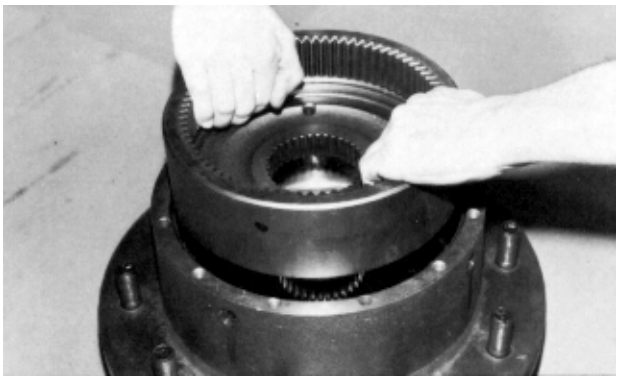
⚠ CAUTION

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING INSTALLATION.

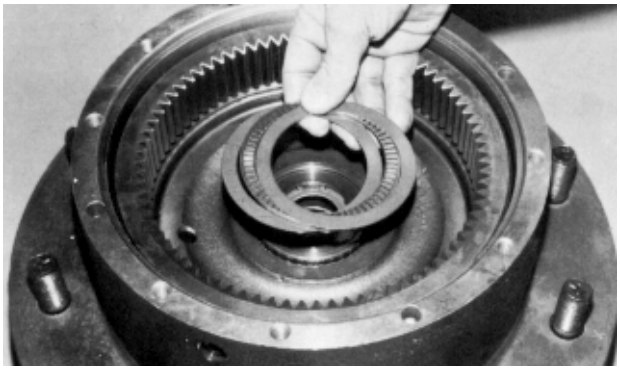
7. Install new retaining ring (9) completely into spindle groove and against bearing shim. Ensure retaining ring is entirely in groove.



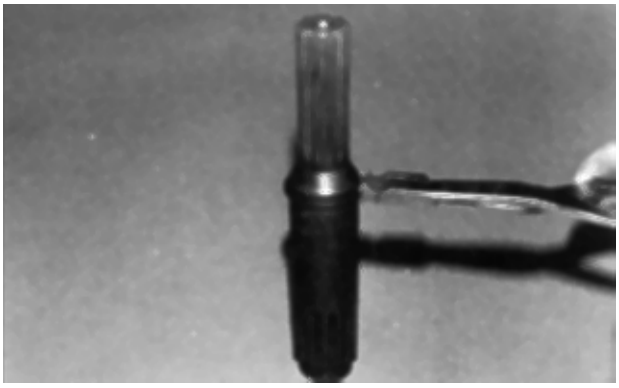
8. Place internal gear (12) onto end of spindle.



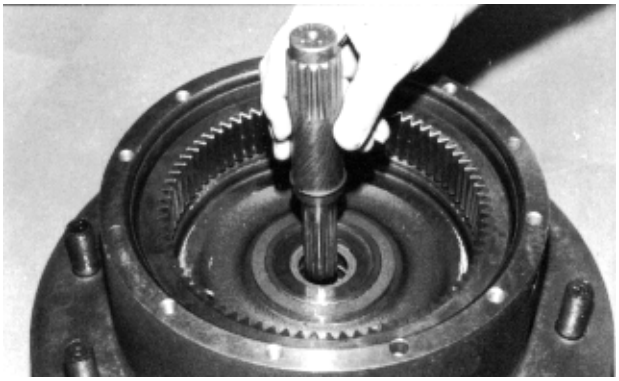
9. Install thrust washers and thrust bearing (39, 40) on the portion of the spindle which extends into the internal gear.



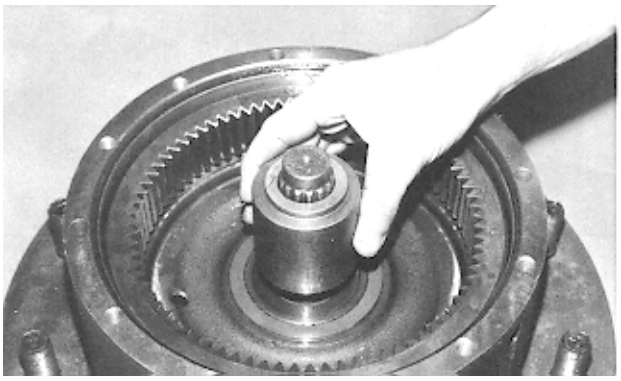
10. Install retaining ring (34) into input shaft retaining ring groove.



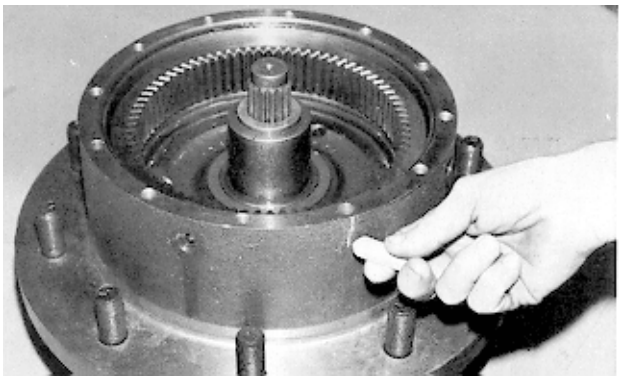
11. Place input shaft assembly (35) into spindle bore with unsplined end facing out.



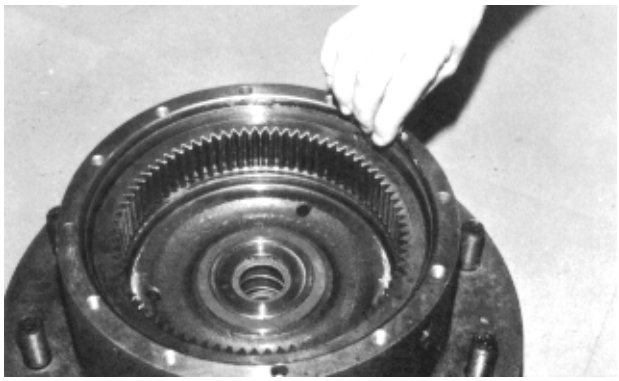
12. Place thrust spacer (36) over input shaft (35) with counter bore side facing spindle.



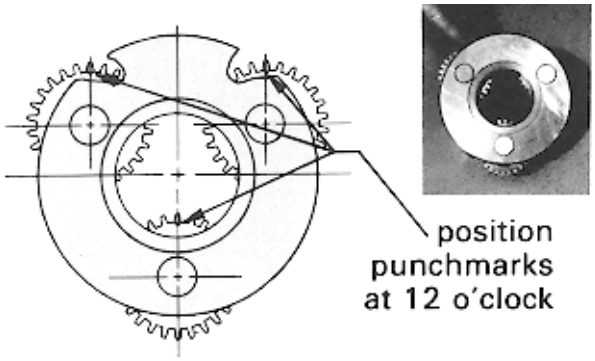
13. Locate the four counter reamed holes in the face of the hub, mark them for later identification.



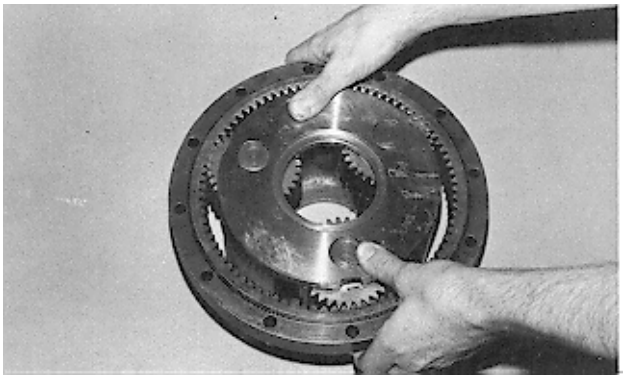
14. Place o-ring (22) into hub counter bore. Use petroleum or grease to hold o-ring in place. Slight stretching of o-ring may be necessary to insure proper seating.



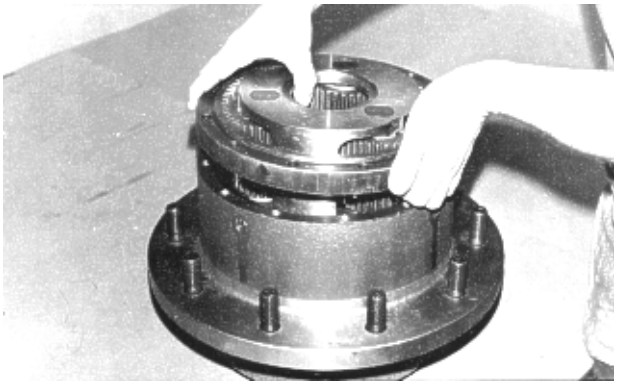
15. Place carrier assembly on a flat surface with large gears up and positioned as shown. Find punch marked tooth on each large gear and locate at 12 o'clock (straight up) from each planet pin. Marked tooth will be located just under carrier on upper two gears.



16. With shoulder side of ring gear (21) facing down, place ring gear over (into mesh with) large gears. Ensure punch marks remain in correct location during ring gear installation.

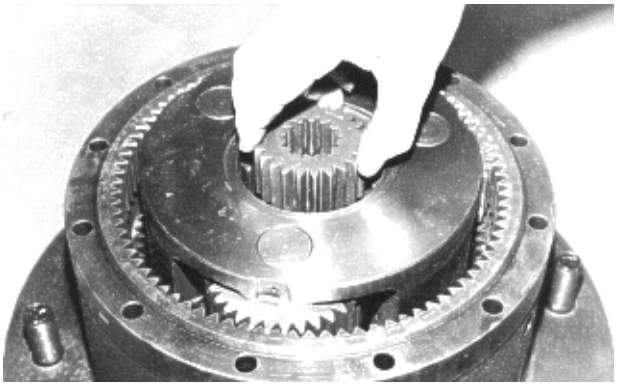


17. While holding ring gear, input gear, and cluster gears in mesh, place small side of cluster gears into mesh with internal gear. On ring gear, locate hole marked 'X' over one of counter bored holes in hub.

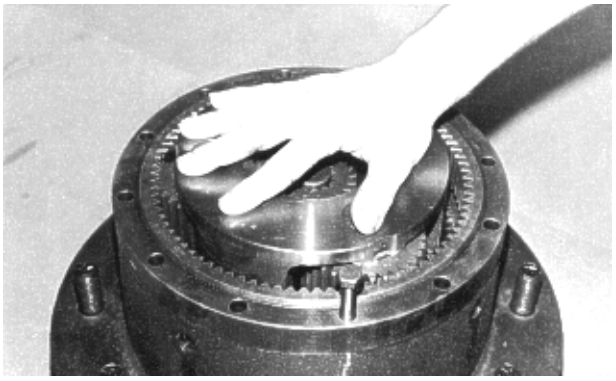


NOTE: *If gears do not mesh easily or carrier assembly does not rotate freely, then remove carrier and ring gear and check cluster gear timing.*

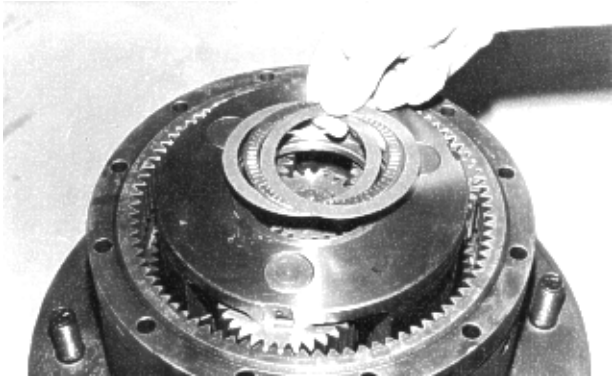
18. Install input gear (37) into carrier, meshing with large diameter cluster gears (18). Counter bore in bore of input gear must be to outside of carrier assembly.



19. After inserting at least one shoulder bolt in the proper location, rotate the carrier. Check freedom of rotation and timing.



20. Install thrust washers and thrust bearing (39, 40) into carrier counter bore.

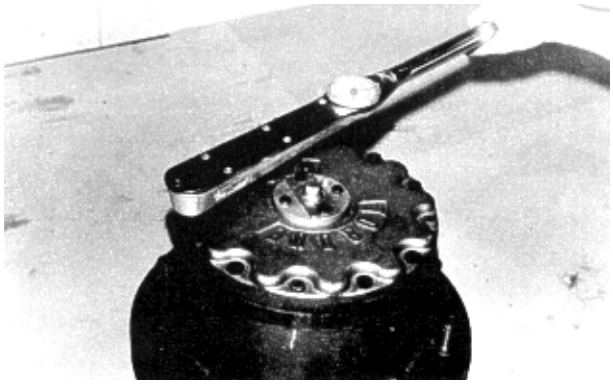


21. Place o-ring (22) into cover assembly counter bore. Use petroleum jelly or grease to hold o-ring in place.

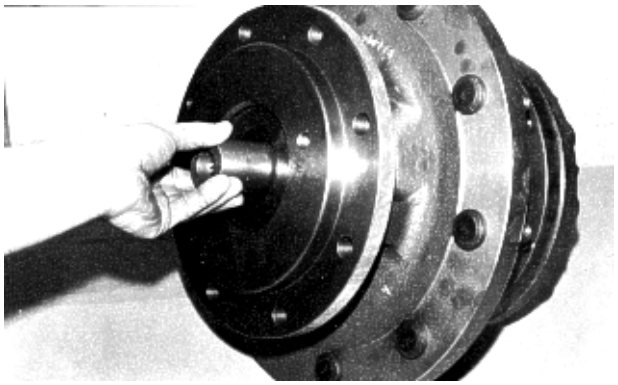
22. Place cover assembly over ring gear with oil level check plug in cover located approximately 90 degrees from oil fill plug in hub.

23. Locate four shoulder bolts (42), 90 degrees apart into counter bored holes in hub marked in step (13). Torque shoulder bolts to 47 ft. lbs. (64 Nm).

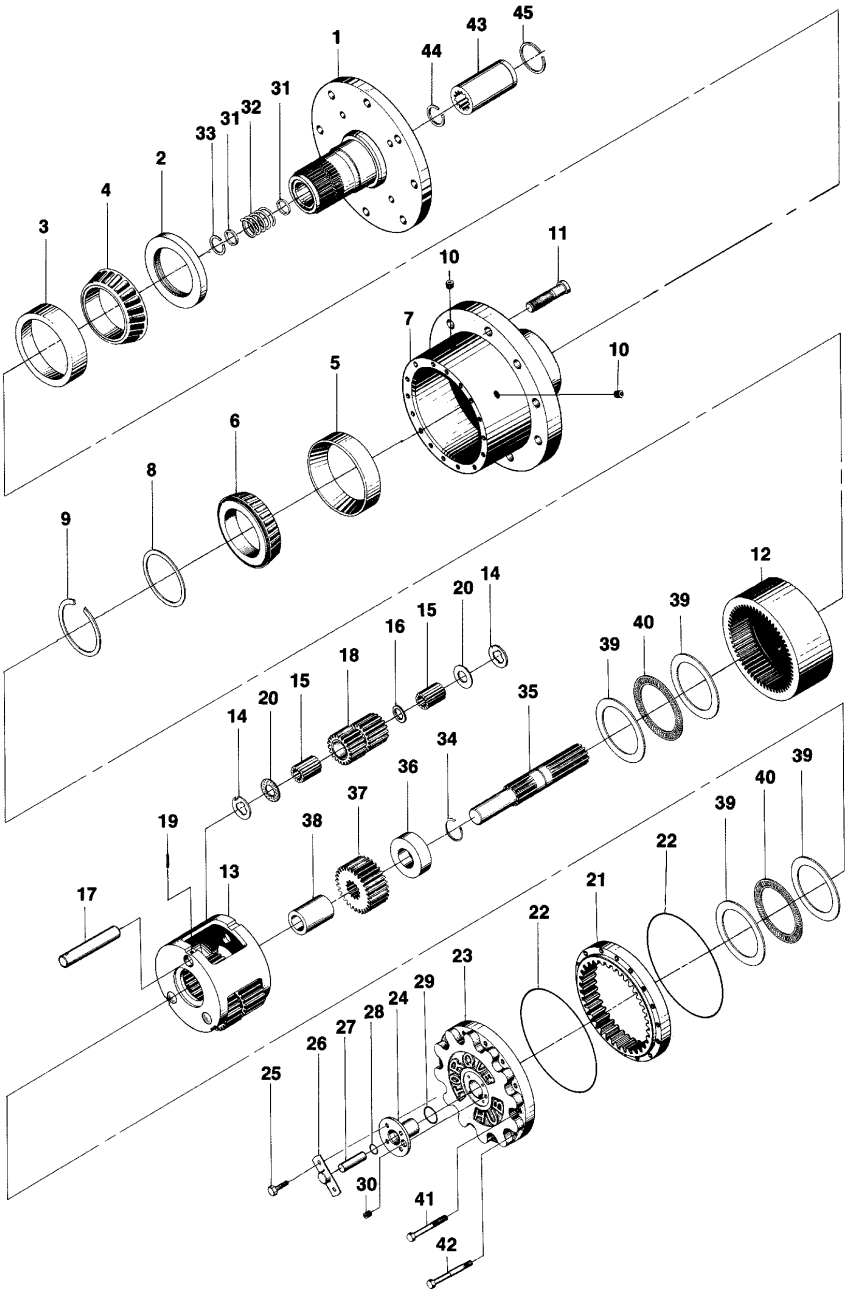
24. Install bolts (41) in remaining holes. Torque bolts to 64 Nm (47 ft. lbs.).



25. Place coupling (1) into spindle and onto input shaft.



26. Fill hub one-half full of EPGL 90 lubricant before operation.



1. Spindle
2. Seal
3. Bearing Cup
4. Bearing Cone
5. Bearing Cup
6. Bearing Cone
7. Hub
8. Spacer
9. Retaining Ring
10. Pipe Plug
11. Bolt
12. Internal Gear
13. Carrier
14. Thrustwasher
15. Needle Roller
16. Spacer
17. Pinion Shaft
18. Cluster Gear
19. Roll Pin
20. Thrustwasher
21. Ring Gear
22. O-ring
23. Cover
24. Cover Cap
25. Bolt
26. Disconnect Cap
27. Disconnect Rod
28. O-ring
29. O-ring
30. Pipe Plug
31. Washer
32. Spring
33. Retaining Ring
34. Retaining Ring
35. Input Shaft
36. Thrust Spacer
37. Input Gear
38. Thrust Spacer
39. Thrustwasher
40. Thrust Bearing
41. Bolt
42. Shoulder Bolt
43. Coupling
44. Retaining Ring
45. Retaining Ring

Figure 3-1. Torque Hub, Drive (Fairfield)

3.2 TORQUE HUB, DRIVE (AUBURN GEAR)

Disassembly

1. Position hub over suitable container and remove drain plugs (27) from unit. Allow oil to completely drain, then replace drain plugs.
2. Remove twelve bolts (25) and flat washers (26) and the cover from the hub (9). The thrust washer (21) and the disengage plunger (22) usually remain with cover (24) when it is removed. Remove thrust washer (21), disengage plunger (22) and o-ring (23) from the cover (24), discard o-ring seal (23).
3. Remove primary sun gear (20) from input shaft (2).
4. Remove the primary carrier assembly (19).
5. Remove the secondary carrier assembly (18). It may be necessary to remove the ring gear (17) first, if difficulty is encountered removing the carrier.
6. Remove the input shaft (2) from spindle (3). Remove the retaining rings (14), washers (15), and spring (16) from input shaft (2) only if replacement is required.

NOTE: *The retaining rings (14), washers (15) and disengage spring (16) are not included in unit equipped with a cast iron disengage cover (29).*

7. If not previously removed (see step 5), remove ring gear (17) from hub (9). It may be necessary to strike ring gear (17) with a rubber mallet to loosen from hub (9).
8. Remove the retaining ring (13) from groove in spindle (3).

NOTE: *Use a retaining ring expander tool to remove retaining ring (13).*

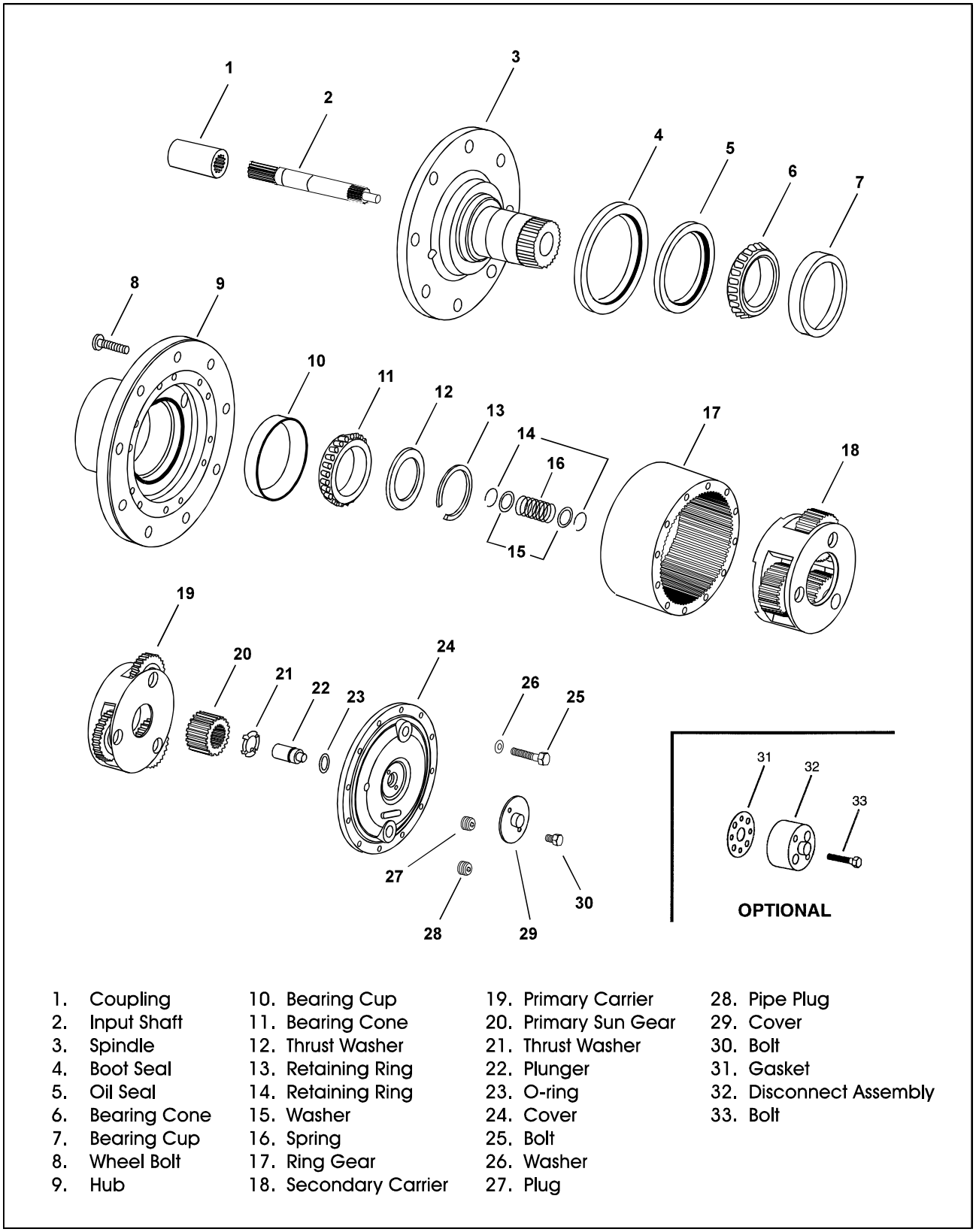
9. Lift hub (9) from spindle (3). If bearings are not a loose fit, it may be necessary to press spindle (3) from hub (9).
10. Remove oil seals (4) and (5) and bearing cones (6 & 11) from the hub (9). Inspect bearing cups (7 & 10) in position and remove only if replacement is required.

Assembly

1. If necessary press new bearing cups (7 & 10) in each end of the hub (9). It is recommended that bearing cups (7 & 10) and cones (6 & 11) be replaced in sets.
2. Assemble bearing cone (6) into cup (7) at seal end of hub (9) and press a new seal (5) into hub. Install boot seal (4) on the hub (9) if hub is so equipped.
3. Position spindle (3) upright on bench. Lubricate lips of seals (4) and (5) and lower hub onto spindle (3). Hub should be centered as it is lowered over spindle (3) to prevent seal damage.
4. Assemble bearing cone (11) over spindle (3) and into bearing cup (10). Replace thrust washer (12) over spindle end splines and on bearing cone (11).
5. Select the thickest ring (13) that can be assembled into the ring groove of the splined end of spindle (3) above bearing. Bearing should have from 0.00 - 0.15 mm (0.000 - 0.006 inches) of end play when proper retaining ring (13) is installed.
6. For hubs equipped with the standard spring disconnect or optional quick disconnect, assemble a washer (15), spring (16), a second washer (15), and retaining ring (14) in the middle grooves of the input shaft (2). Install second retaining ring (14) in groove near small end of input shaft.
7. Assemble the splined end of the input shaft (2) down into spindle (3).
8. Assemble the secondary carrier assembly (18) to spindle (3) at splines.
9. Clean mating surfaces and apply a bead of silicone sealant to face of hub (9) that mates with ring gear (17). Assemble ring gear (17) to hub (9), being careful to align bolt holes.
10. Assemble the primary carrier assembly (19) into the ring gear (17). It will be necessary to rotate carrier to align secondary sun gear (part of primary carrier assembly (19)) with planet gear teeth in secondary carrier assembly (18). Assemble primary sun gear (20) over input shaft (2). Rotate primary sun gear (20) to align input shaft (2) to gear splines and gear teeth in primary carrier assembly (19).
11. Lubricate o-ring (23) and assemble in groove inside cover hole, then push disengage plunger (22) into cover with pointed end facing inside of hub.

NOTE: *These parts (22 & 23) are not included in hubs produced with a cast iron disengage cover (29).*

12. For hubs with the standard spring disengage, assemble the thrust washer (21) with tangs engaged with cover (24). Note: A small amount of grease applied to the back side of thrust washer (21) will hold washer in place.
13. Assemble cover (24), aligning holes of cover and ring gear. Assemble the twelve bolts (25) and flat washer (26). Torque bolts to 61 - 67 Nm (45 - 50 ft. lbs.).



1. Coupling
2. Input Shaft
3. Spindle
4. Boot Seal
5. Oil Seal
6. Bearing Cone
7. Bearing Cup
8. Wheel Bolt
9. Hub
10. Bearing Cup
11. Bearing Cone
12. Thrust Washer
13. Retaining Ring
14. Retaining Ring
15. Washer
16. Spring
17. Ring Gear
18. Secondary Carrier
19. Primary Carrier
20. Primary Sun Gear
21. Thrust Washer
22. Plunger
23. O-ring
24. Cover
25. Bolt
26. Washer
27. Plug
28. Pipe Plug
29. Cover
30. Bolt
31. Gasket
32. Disconnect Assembly
33. Bolt

Figure 3-2. Torque Hub, Drive (Auburn Gear)

3.3 DRIVE BRAKE - AUSCO

Disassembly

1. With the shaft protrusion downward, disassemble the parts in the following order; bolts (24) alternately, washers (23), power plate (21), and gasket.
2. Remove the following parts; stationary discs (14), rotating discs (12), primary disc (11), torque pins (3), springs (8&9), and the spring retainer (7).

NOTE: *If the bearing and seal are removed for any reason both must be replaced.*

3. Further disassembly is not recommended and should not be attempted unless necessary to replace the bearing (4), the seal (6), or the shaft (10). If further disassembly is needed, proceed as follows;
   a. The shaft (10) may be removed by pressing on the end of the shaft with a shop press.
   b. Using an appropriate tool, pry the seal (6) out from the inside of the brake. Take care not to damage the bore. Remove the retaining ring (5). Tap the bearing (4) out with a plastic mallet.
4. Remove the piston (15) from the power plate (21) by introducing low pressure air into the hydraulic inlet and make sure the piston is directed away from the operator. Remove the o-rings (17&19) and backup rings (16 & 18) from the piston O.D. and I.D. grooves. Do not remove backup rings (16 & 18) unless replacement is necessary because they will be damaged.With shaft protrusion downward, remove end cover (13) by removing capscrews (12).

Inspection

1. Clean all parts thoroughly.
2. Closely inspect all parts for excessive wear, cracks and chips. Replace parts as necessary.
3. Discard seals and o-rings.
4. Closely inspect bearings and bearing contact surfaces. Replace as necessary.

Assembly

⚠ IMPORTANT

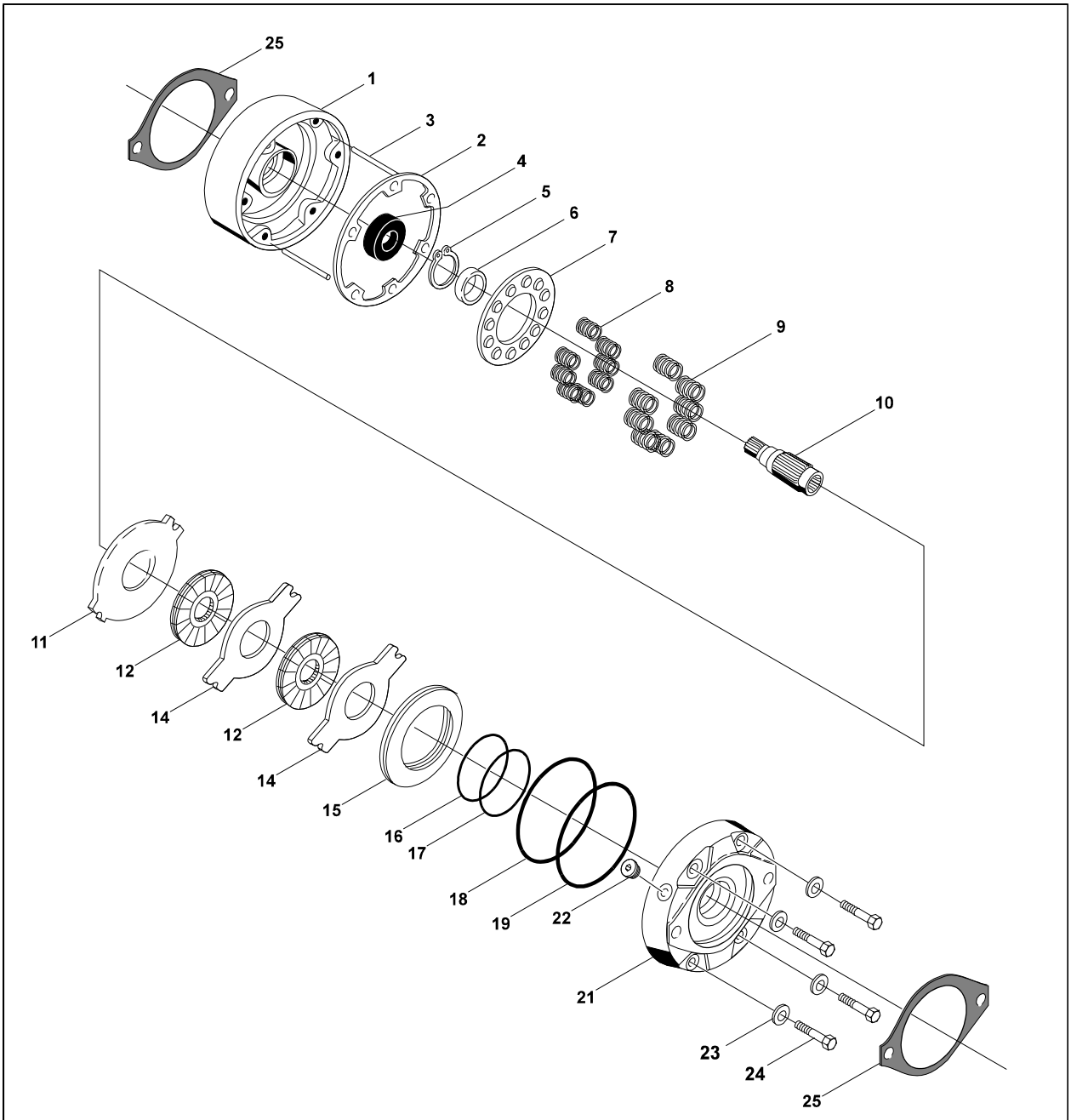
THERE MAY BE MORE PARTS IN A SERVICE KIT THAN YOUR BRAKE REQUIRES. CHECK THE PARTS LIST CAREFULLY FOR THE EXACT QUANTITY. IN THE CASE OF SPRINGS, SPACE THE SPRINGS AS SHOWN IN THE FIGURE.

1. Worn o-rings and damaged or worn Teflon backup rings must be replaced prior to assembly.
2. The cylinder of the power plate, piston, and o-rings must be clean prior to assembly and pre-lubed with the system hydraulic fluid.

⚠ CAUTION

THE DEPTH THE PISTON IS INSTALLED INTO THE POWER PLATE IS CRITICAL. THE SURFACE OF THE PISTON AT THE CUTOUTS MUST BE FLUSH TO 3.048 MM (0.120 IN) BELOW THE SURFACE OF THE POWER PLATE. DO NOT EXCEED THE 3.048 MM (0.120 IN) DEPTH OR THE PISTON WILL COCK RESULTING IN A COMPLETE LOSS OF BRAKING.

3. Assemble the piston (15) into the power plate (21) using a shop press, being careful not to damage the o-rings or Teflon back-up rings. Visually align the center of the cutouts in the piston with the torque pin (3) holes in the power plate (21).
4. For replacement of the seal;
   a. Use a shop press to install the bearing (4) into the housing. Press on the outer surface of the bearing only. Install the retaining ring (5) into the groove.
   b. Press the seal (6) into the housing (1) until it is flush with the face of the housing. The lip of the seal must face towards the bearing.
5. Press the shaft into the housing until it stops on the bearing. Support the inner race of the bearing during the press operation.
6. Rotating discs must be clean and dry. The lining material and mating surfaces of the stationary discs must be thoroughly clean and free of debris. Worn or scored rotating discs must be replaced.
7. Install bolts (24) with washers (23) in the power plate (21). Tighten sequentially, one turn at time, until the power plate is properly seated. Torque 105 to 115 foot-pounds.



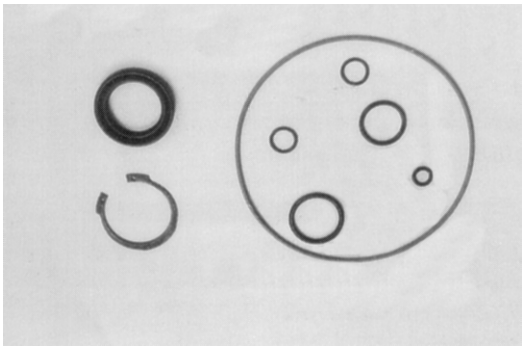
1. Housing
2. Gasket
3. Torque Pin
4. Ball Bearing
5. Retaining Ring
6. Seal
7. Spring Retainer
8. Small Compression Spring
9. Large Compression Spring
10. Shaft
11. Primary Disc
12. Rotating Disc
13. Not Used
14. Stationary Disc
15. Piston
16. Back-up Ring
17. O-ring
18. Back-up Ring
19. O-ring
20. Bleeder Screw
21. Power Plate
22. Protective Plug
23. Washer
24. Bolt
25. Gasket

Figure 3-3. Drive Brake Assembly (Ausco)

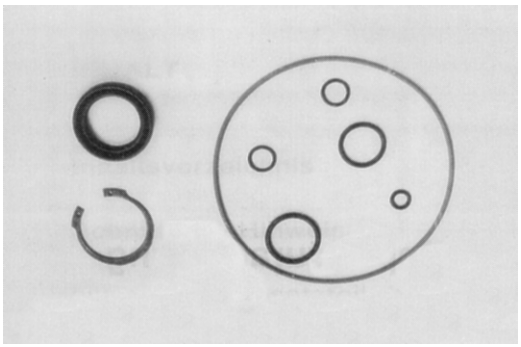
3.4 DRIVE MOTOR

Spare Parts Kits

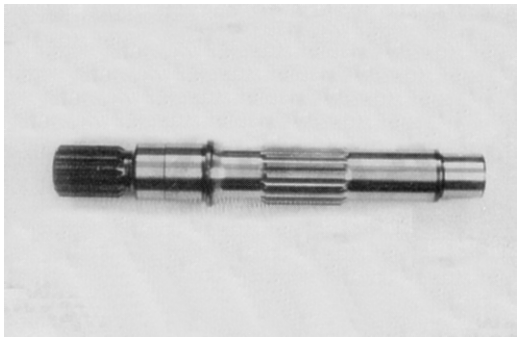
Sealing kit, existing spare parts: shaft sealing ring, 6 different O-rings and a circlip (sealing mat.: perbunan)

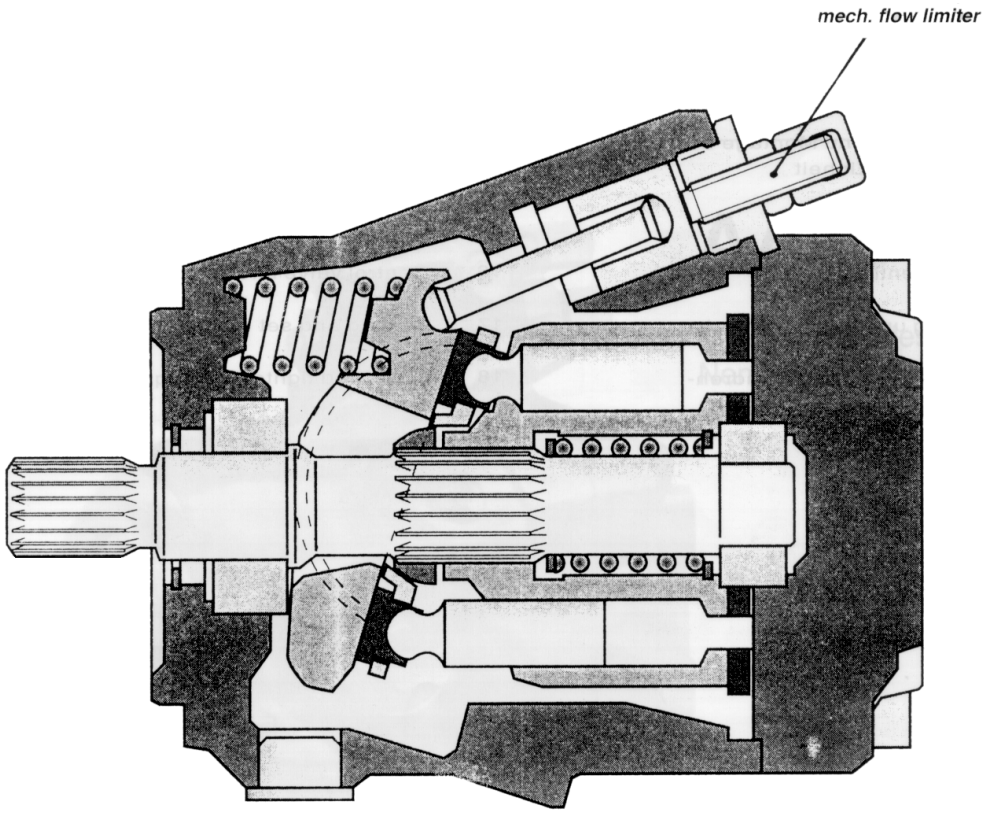


Same sealing kit like shown above only seal material changed to Viton

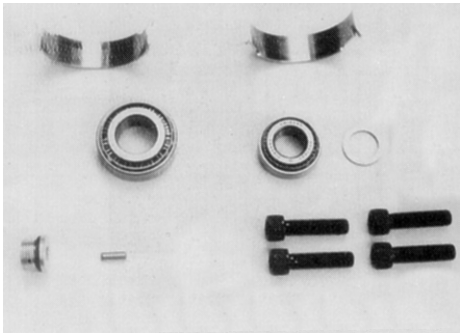


Drive shaft

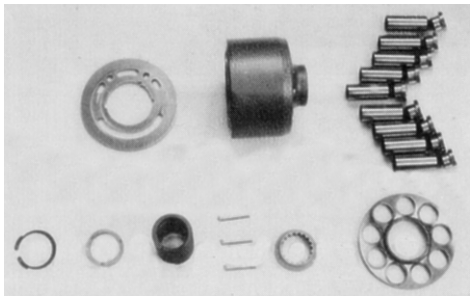




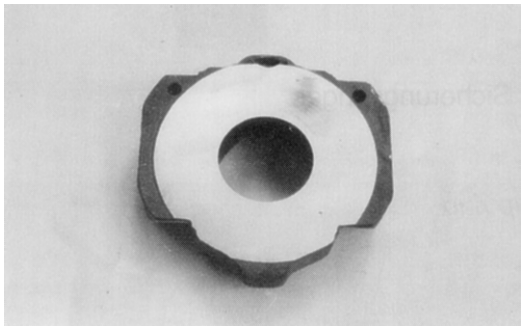
Bearing set/miscellaneous parts



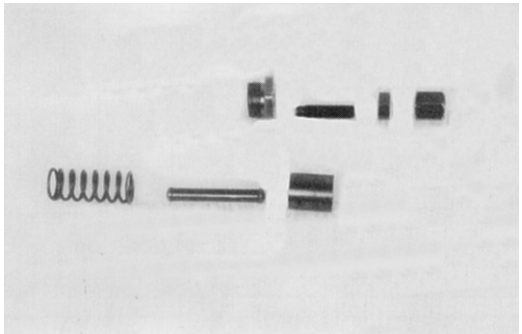
Rotary group complete 9 pistons, cylinder sub-assembly, valve plate (cw or ccw corresponding to the order) retaining plate and retaining ball.



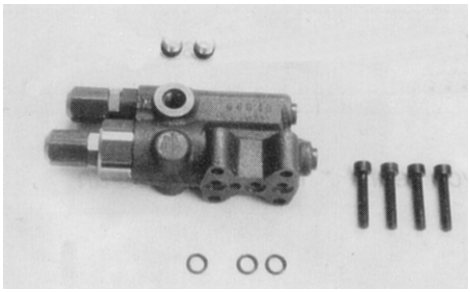
Swash Plate



Parts of the control device: control piston, piston rod, plug, spring stopper max flow, hex. nut, and hex. head nut

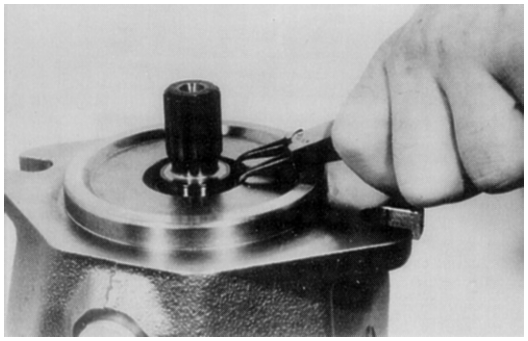


Spare parts kit DFR pilot valve



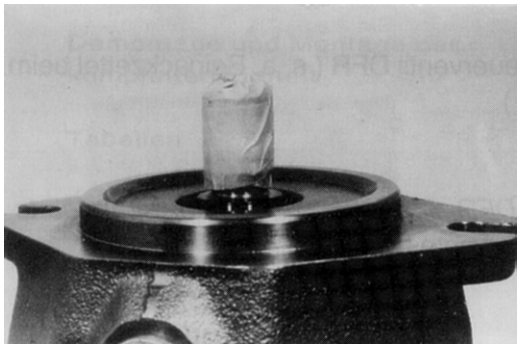
Replacing the Drive Shaft Seal

1. Remove the snap ring

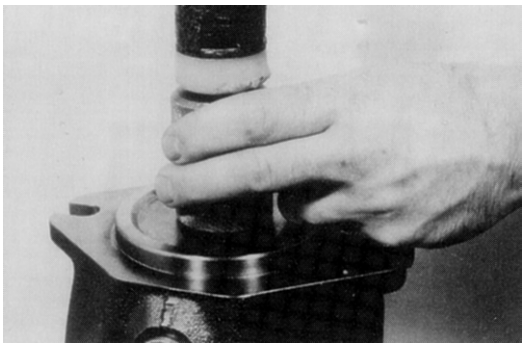


2. Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.

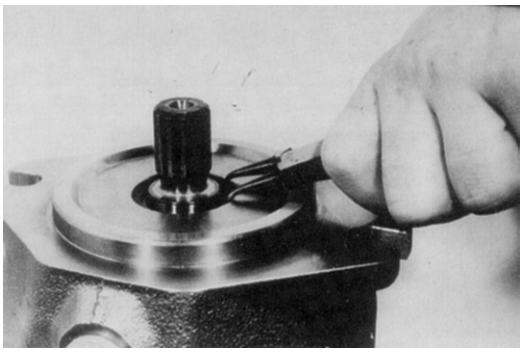
3. Be careful while you seal the drive shaft, use an adhesive tape to protect the splines.



4. Assemble the sealing ring. The fitting tool will hold the sealing ring in the correct position in the pump housing.



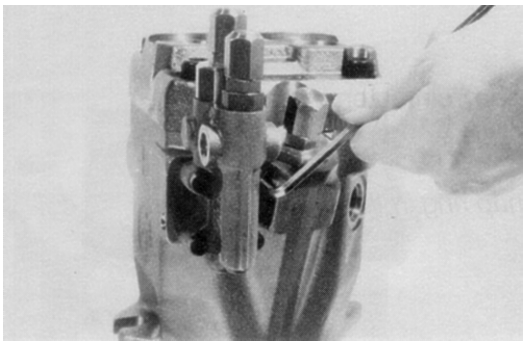
5. Assemble the snap ring.



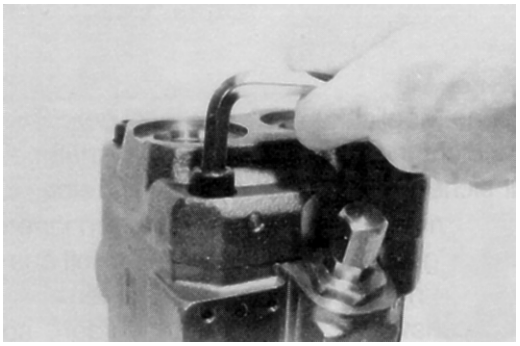
6. Assemble the snap ring in the correct position.

Disassembly and Assembly

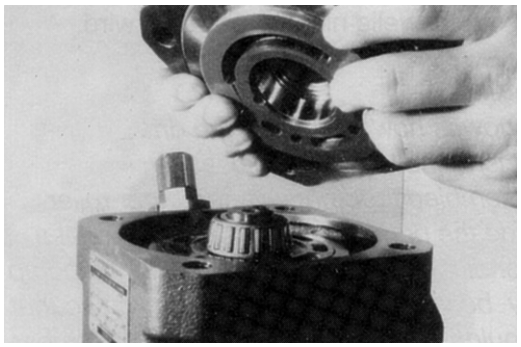
1. Disassemble the pilot valve.



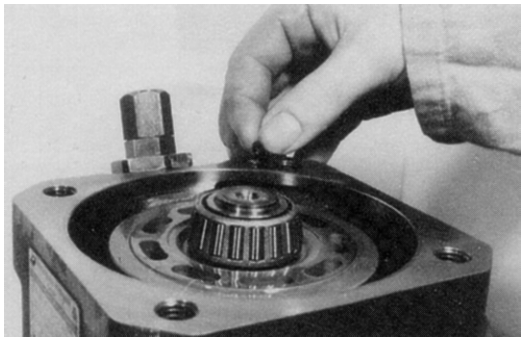
2. Mark the position of the port plate and remove the socket screw from the port plate.



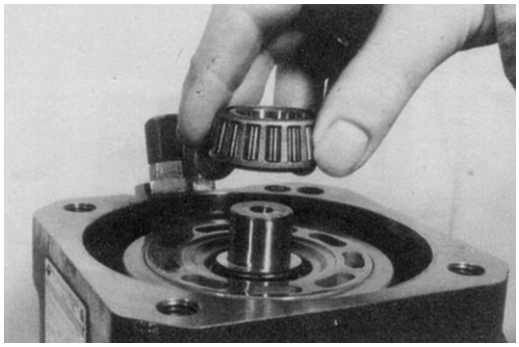
3. Remove the port plate together with the valve plate (hold the valve plate so that the plate can't fall down).



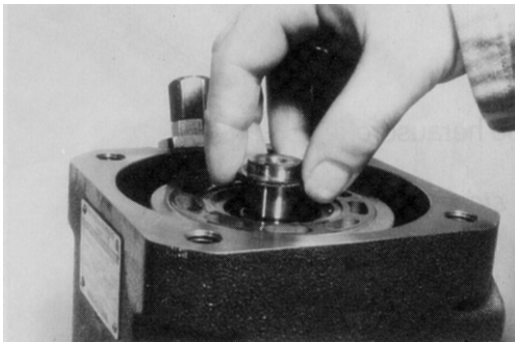
4. Remove the O-ring.



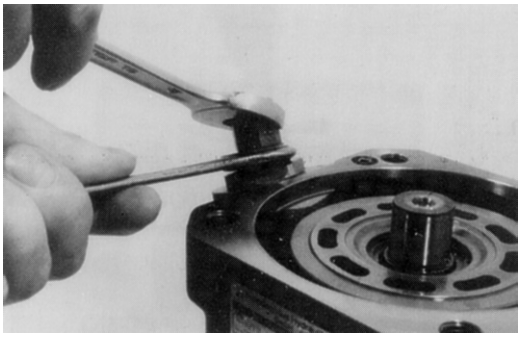
5. Disassemble the taper roller bearing.



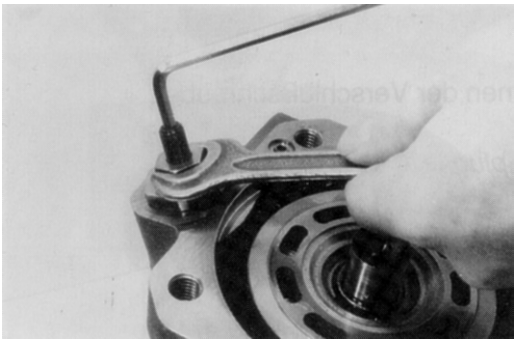
6. Remove the adjustment shim.



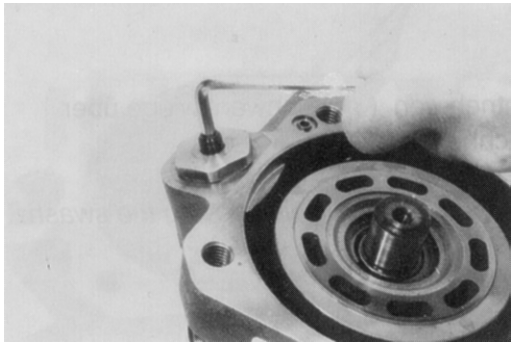
7. Unscrew the cap nut and remove it.



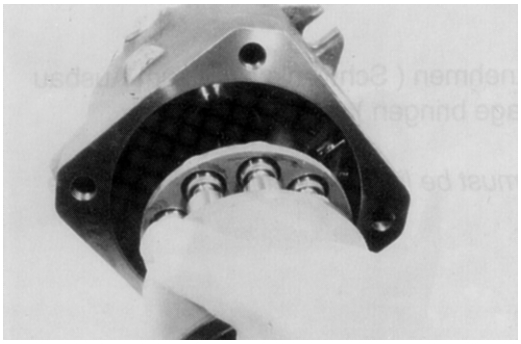
8. Loosen the retaining nut of the stopper max flow and remove it.



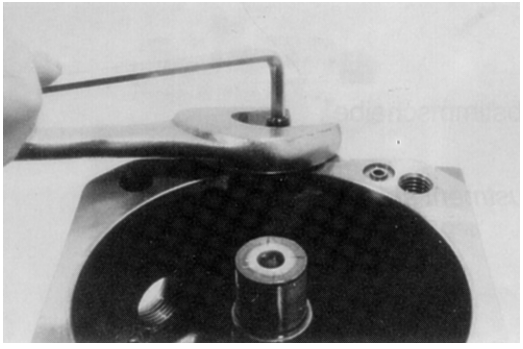
9. Turn in the stopper max flow to get swivel angle zero.



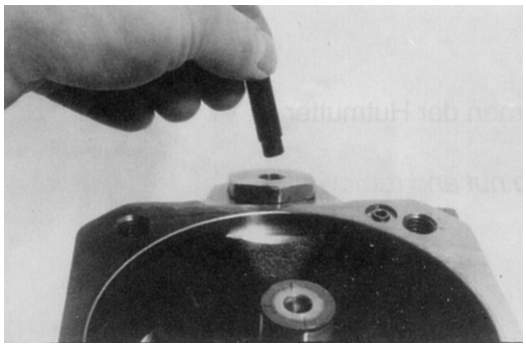
10. Disassemble the rotary group in horizontal position.



11. Disassemble the stopper - max. flow.

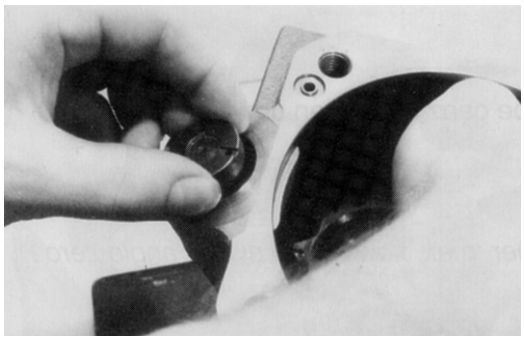


12. Remove the threaded pin (stopper - max.flow)

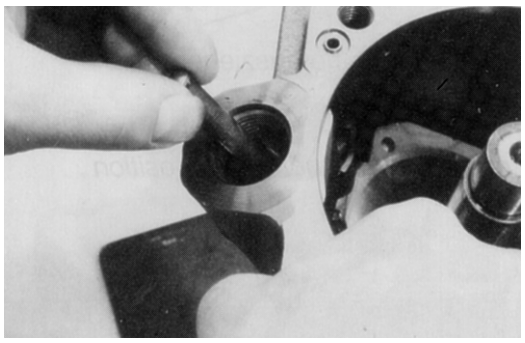


13. Disassemble the plug.

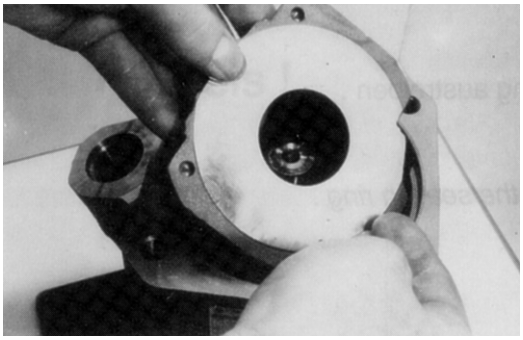
14. Disassemble the control piston while moving the swash plate.



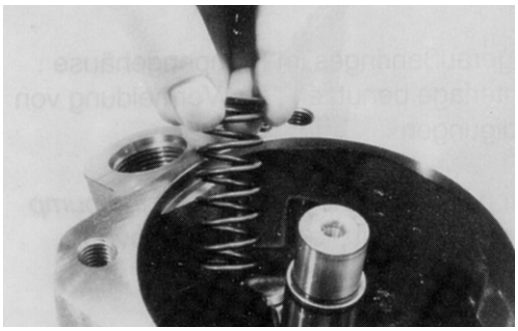
15. The swash plate must be lifted a little bit to disassemble the piston rod.



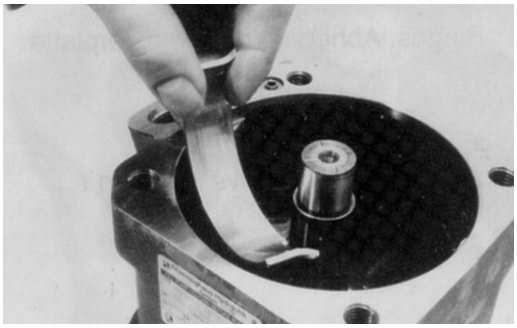
16. Disassembly of the swash plate.



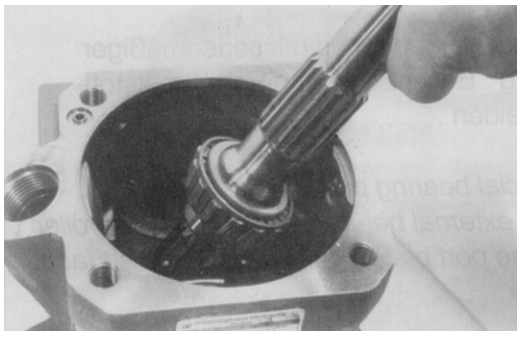
17. Remove the spring.



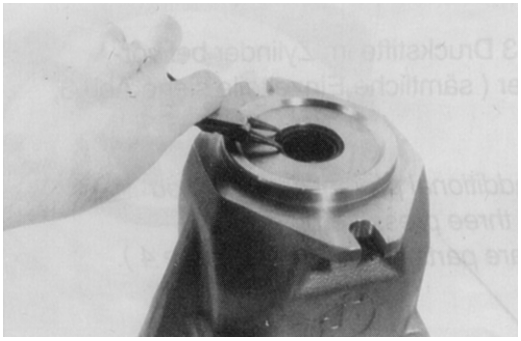
18. Remove both bearing shells.



19. Remove the drive shaft.

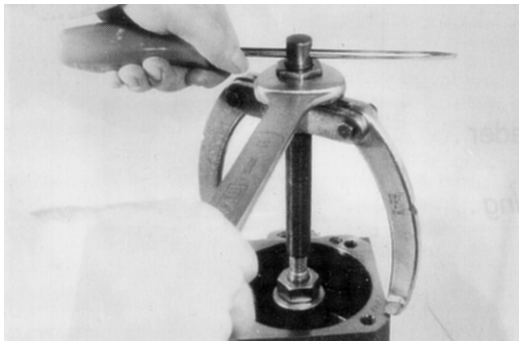


20. Remove the snap ring.

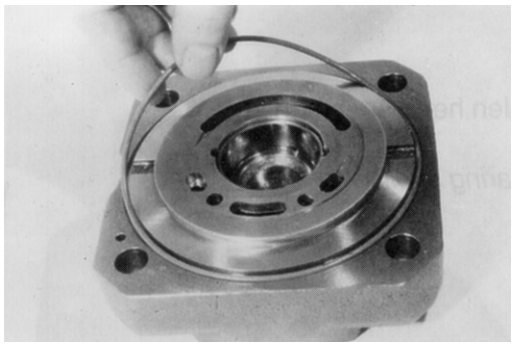


21. Disassemble the sealing ring.

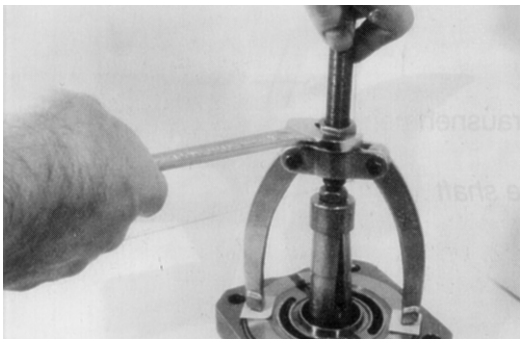
22. The external front bearing ring is pulled out of the pump housing.



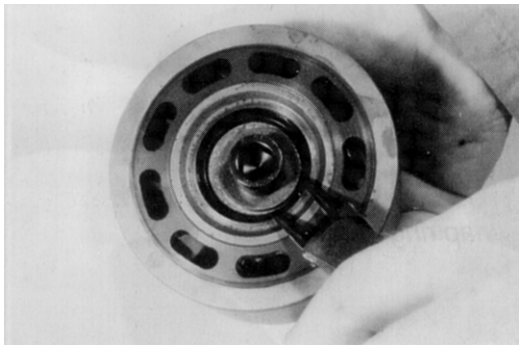
23. Remove the O-ring. Lifting of the valve plate isn't shown.



24. A usual commercial bearing puller is used to disassemble the external bearing ring of the taper roller bearing inside the port plate. Take care not to damage the surface of the port plate.

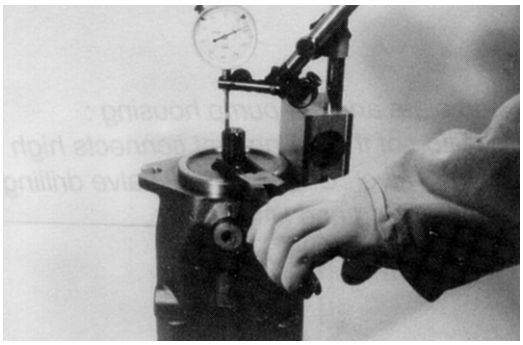


25. The spring has additional pretension while you disassemble the three pressure pins inside the cylinder.

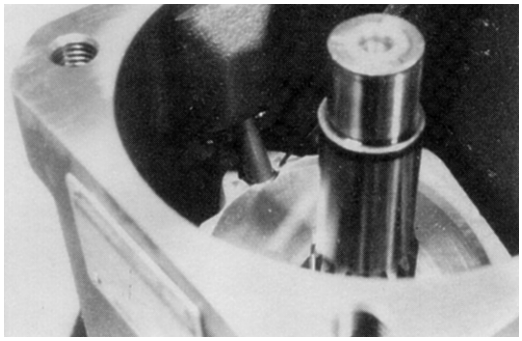


Assembly Notes

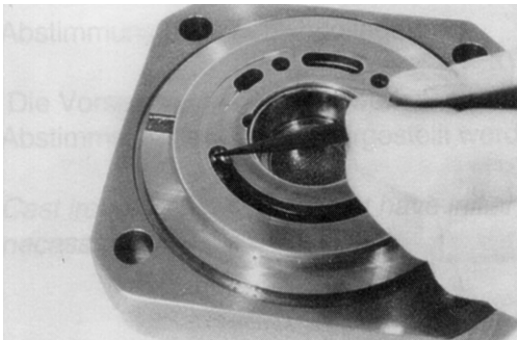
1. Measurement of the taper roller bearing pretension.



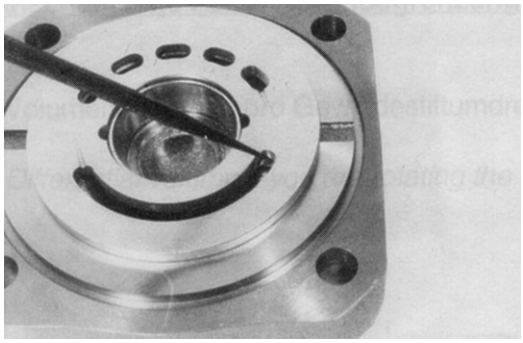
2. Note that there is a correct connection of the piston rod and the swash plate.



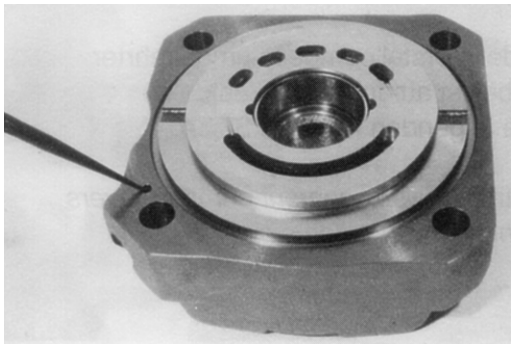
3. Pumps clockwise driven must have a position to the valve plate 4 degrees out of center in the same direction de-centered like drive direction. (Note spare parts exist as cw and ccw valve plates.)



4. Pumps counterclockwise driven must have a position of the valve plate 4 degrees de-centered in ccw position.

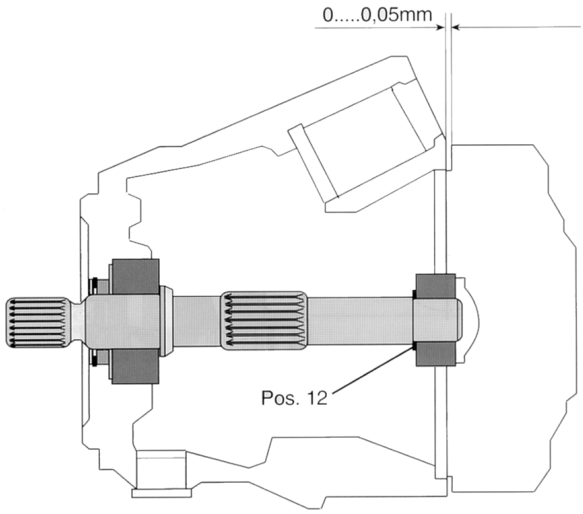


5. Assembly of the port plate and the pump housing: Note the correct position of the drilling that connects high pressure to the control valve. Check control valve drill position at the pump housing and fit together.

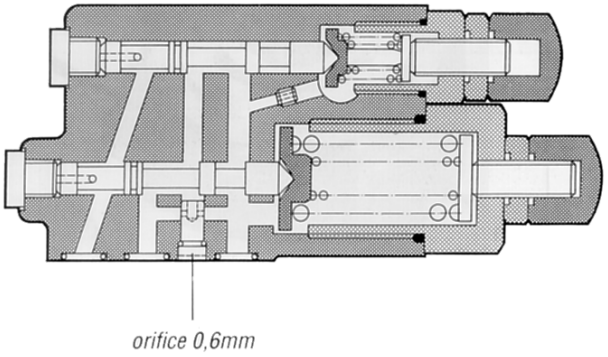


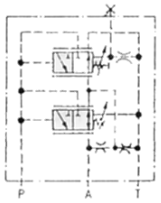
Taper Roller Bearing Initial Tension

Cast iron pump housing must have initial tension of the bearings: 0.....0,05 mm, grind Pos. 12 if necessary.

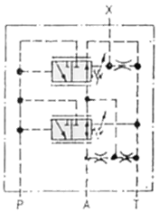


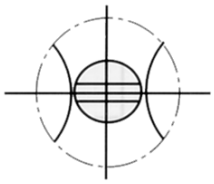
all valves shown here do have open position of the orifice (see picture below "pos. of orifice").

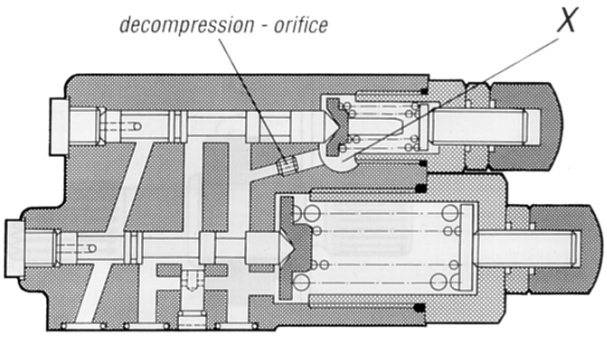




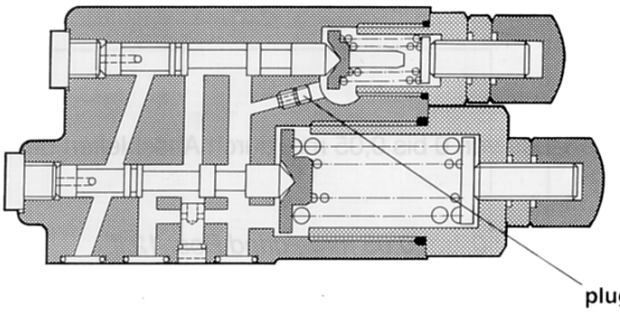
pressure compensator DR
Both X- ports are pluged .
Flow control blocked.

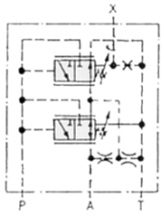




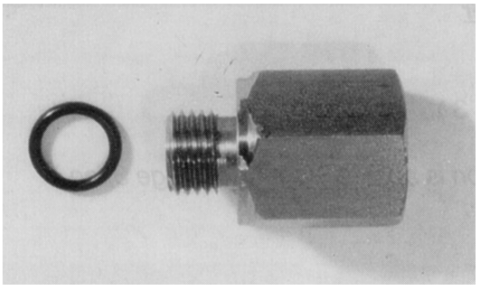


pressure compensator and flow control DFR
One X - port is plugged .





pressure compensator and flow control DFR 1
One X - port is pluged . Decompression orifice X-T is pluged by the plug.



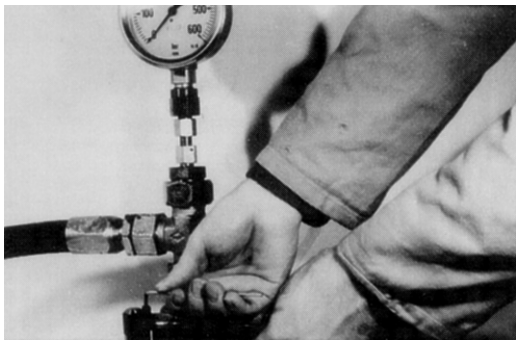
Adapter without orifice of the DFR-pilot valve , if you use a metric pilot pipe connection X .

NOTE: *Differential volume if you are rotating the threaded pin - each rotation is appr. 3,1 cm3.*

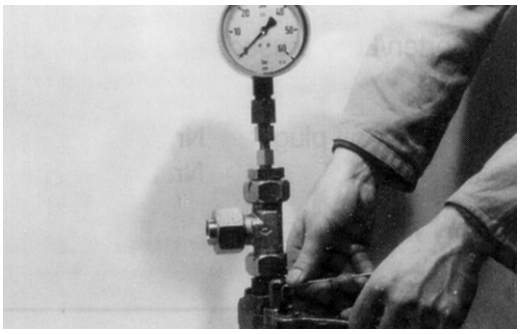
Figure 3-4. Flow Control Pilot Valves

Testing and Setup

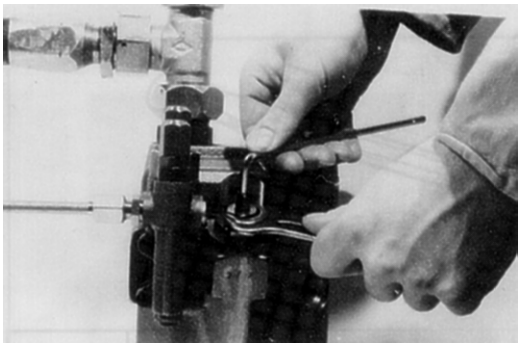
DR: When pressure line is closed adjust the pressure of the controller (if it's DFR design then open the adjustable orifice and increase force of the spring - FR -).

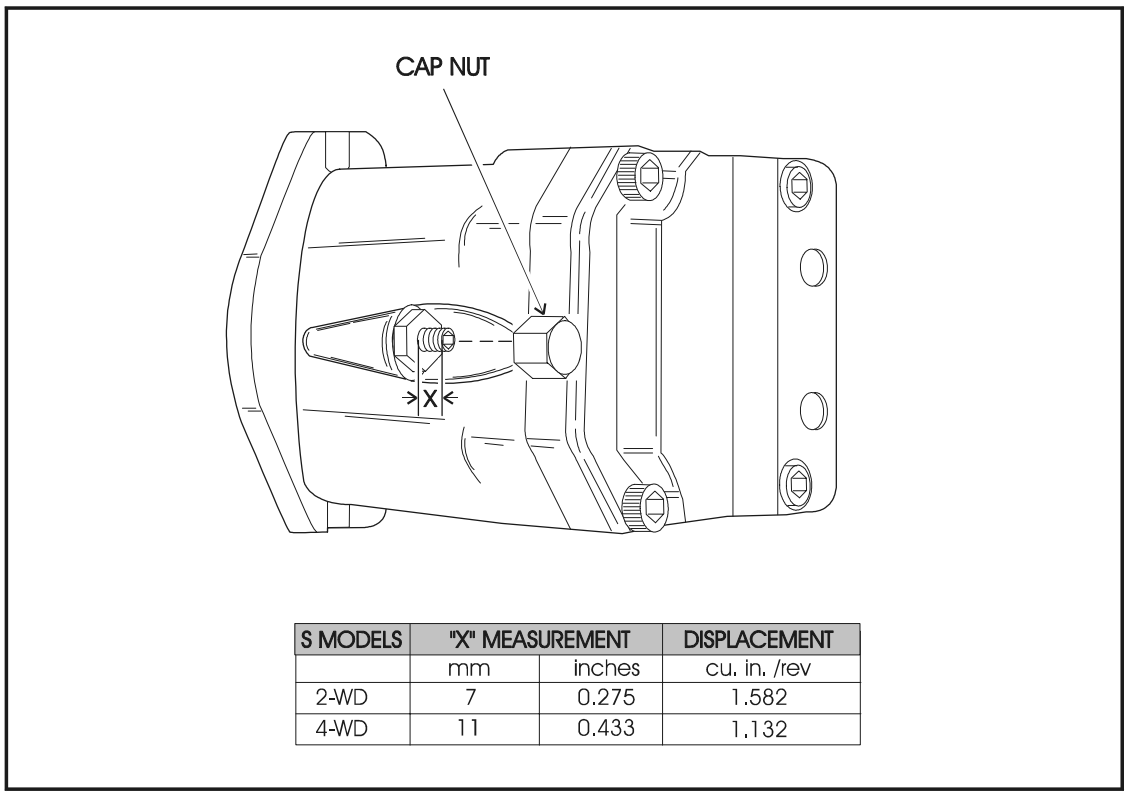


FR: If swivel angle is in the mid position adjust differential pressure 14 bar adjustable orifice is partly closed).



Mechanical flow limiter: While screwing in the threaded pin you will be able to reduce the flow from Vg max to 50% of Vg max.





S MODELS	"X" MEASUREMENT		DISPLACEMENT
	mm	inches	cu. in. /rev
2-WD	7	0.275	1.582
4-WD	11	0.433	1.132

Figure 3-5. Drive Motor Adjustment

3.5 DRIVE MOTOR ADJUSTMENT PROCEDURE

1. Remove the cap nut from adjustment screw.
2. Loosen jam nut on the adjustment screw and make adjustment.
3. Measure from top of jam nut to the end of adjustment screw. (See Figure 3-5., Drive Motor Adjustment.)
4. Tighten jam nut, install cap nut.

NOTE: *The “o” ring must be seated in groove in cap nut.*

)

3.6 FREE WHEELING OPTION

To Disengage Drive Motors and Brakes (Free Wheel) for Towing, etc.

1. Chock wheels securely if not on flat level surface.
2. Disconnect both drive hubs by inverting disconnect caps in center of hubs.
3. If equipped, move steer/tow selector valve to float (tow) position by pulling valve knob out.

To Engage Drive Motors and Brakes (Normal Operation)

1. If equipped, move steer/tow valve to steer position by pushing valve knob in.
2. Connect both drive hubs by inverting disconnect cap in center of hub.
3. Remove chocks from wheels as required.

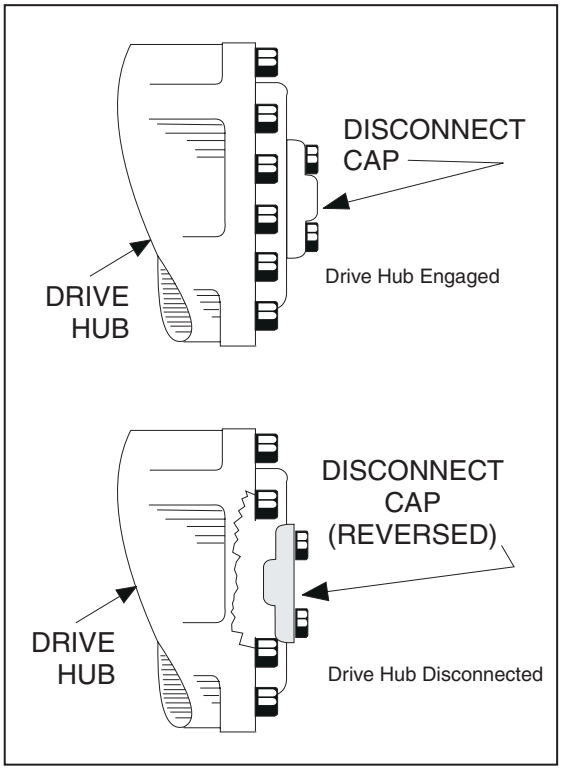


Figure 3-6. Disconnecting the Drive Hubs

3.7 OSCILLATING AXLE BLEEDING PROCEDURE AND LOCKOUT TEST

Lockout Cylinder Bleeding

⚠ IMPORTANT

ENSURE PLATFORM IS FULLY LOWERED AND BOOM IS CENTERED OVER REAR AXLE PRIOR TO BEGINNING BLEEDING PROCEDURE.

MAKING SURE MACHINE IS ON A LEVEL SURFACE AND REAR WHEELS ARE BLOCKED, BRAKE WIRE IS DISCONNECTED.

1. Making sure machine is on a level surface and rear wheels are blocked, brake wire is disconnected.
2. Center boom over rear axle making sure that cam valve is depressed.

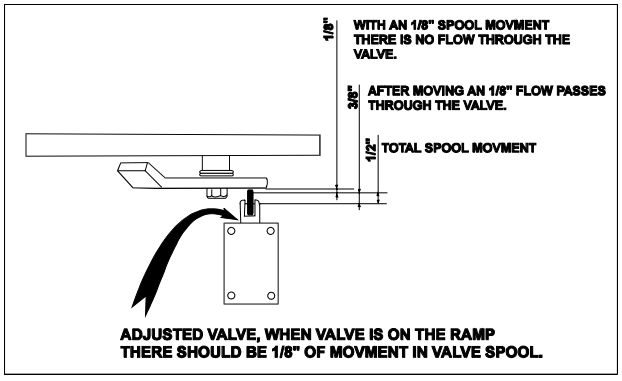


Figure 3-7. Oscillating Valve Adjustment

3. Using a Phillips screwdriver, remove screw from connection on the brake valve and remove connector as shown.

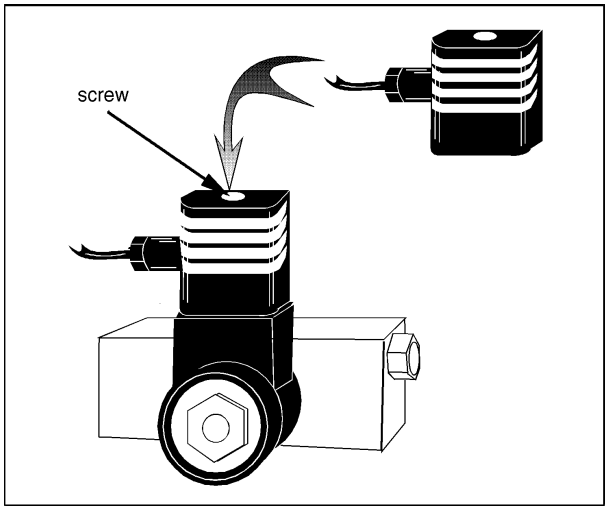


Figure 3-8. Brake Valve Wiring Connection

4. Use suitable containers to retain any residual hydraulic fluid, place containers under each lockout cylinder.
5. Open all four bleeder screws (two on each lockout cylinder).
6. Start the engine, position drive control lever on the main hydraulic pump forward or reverse as shown.

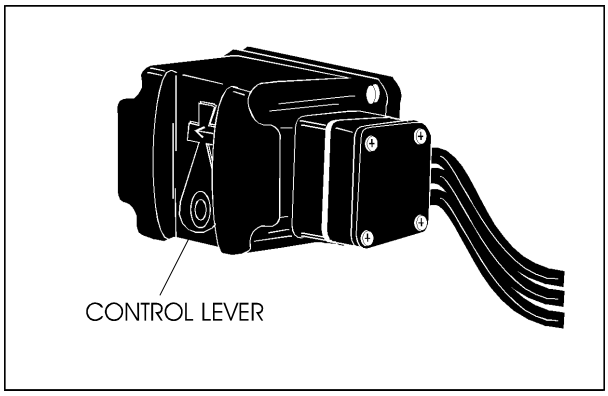


Figure 3-9. Drive Manual Control Valve

7. Close bleeder screws when all air is dissipated (bled).
8. Perform oscillating axle lockout test.
9. If necessary, repeat steps 1 thru 8.

Oscillating Axle Lockout Test

⚠ IMPORTANT

LOCKOUT SYSTEM TEST MUST BE PERFORMED QUARTERLY, ANY TIME A SYSTEM COMPONENT IS REPLACED, OR WHEN IMPROPER SYSTEM OPERATION IS SUSPECTED.

NOTE: *Ensure boom is fully retracted, lowered, and centered between drive wheels prior to beginning lockout cylinder test.*

1. Place a 6 inch (15.2 cm) high block with ascension ramp in front of left front wheel.
2. From platform control station, activate machine hydraulic system.
3. Place FUNCTION SPEED CONTROL and DRIVE SPEED/TORQUE SELECT control switches to their respective LOW positions.
4. Place DRIVE control lever to FORWARD position and carefully drive machine up ascension ramp until left front wheel is on top of block.
5. Carefully activate SWING control lever and position boom over right side of machine.

6. With boom over right side of machine, place DRIVE control lever to REVERSE and drive machine off of block and ramp.

7. Have an assistant check to see that left front wheel remains locked in position off of ground.

8. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). When boom reaches center, stowed position, lockout cylinders should release and allow wheel to rest on ground, it may be necessary activate DRIVE to release cylinders.

9. Place the 6 inch (15.2 cm) high block with ascension ramp in front of right front wheel.

10. Place DRIVE control lever to FORWARD and carefully drive machine up ascension ramp until right front wheel is on top of block.

11. Carefully activate SWING control lever and position boom over left side of machine.

12. With boom over left side of machine, place DRIVE control lever to REVERSE and drive machine off of block and ramp.

13. Have an assistant check to see that right front wheel remains locked in position off of ground.

14. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). When boom reaches center, stowed position, lockout cylinders should release and allow wheel to rest on ground, it may be necessary activate DRIVE to release cylinders.

15. If lockout cylinders do not function properly, have qualified personnel correct the malfunction prior to any further operation.

3.8 STEER ADJUSTMENTS

NOTE: *Spindles do not stop on cylinder stroke. Adjust steering stops as follows: Adjust item #1 to achieve 44° inside turn angles. Steer full left and adjust RH item #2 to contact axle. Steer full right and adjust LH item #2 to contact axle. (2WS/2WD)*

Spindles do not stop on cylinder stroke. Adjust steering stops as follows: Adjust item #1 to achieve 39° inside turn angles. Steer full left and adjust RH item #2 to contact axle. Steer full right and adjust LH item #2 to contact axle. (2WS/4WD)

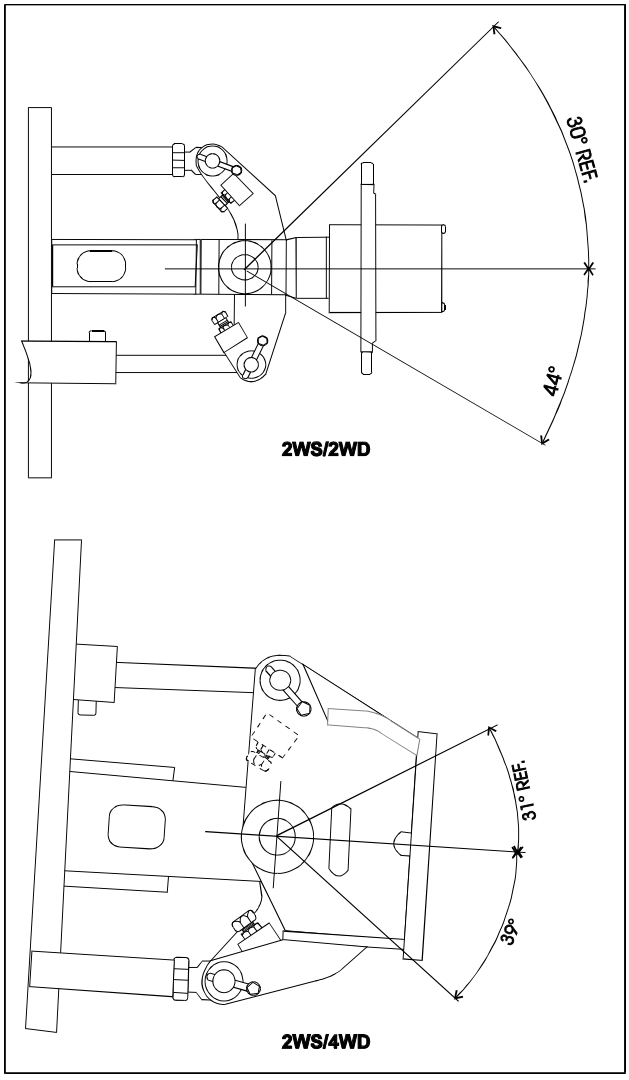


Figure 3-10. Steer Adjustments

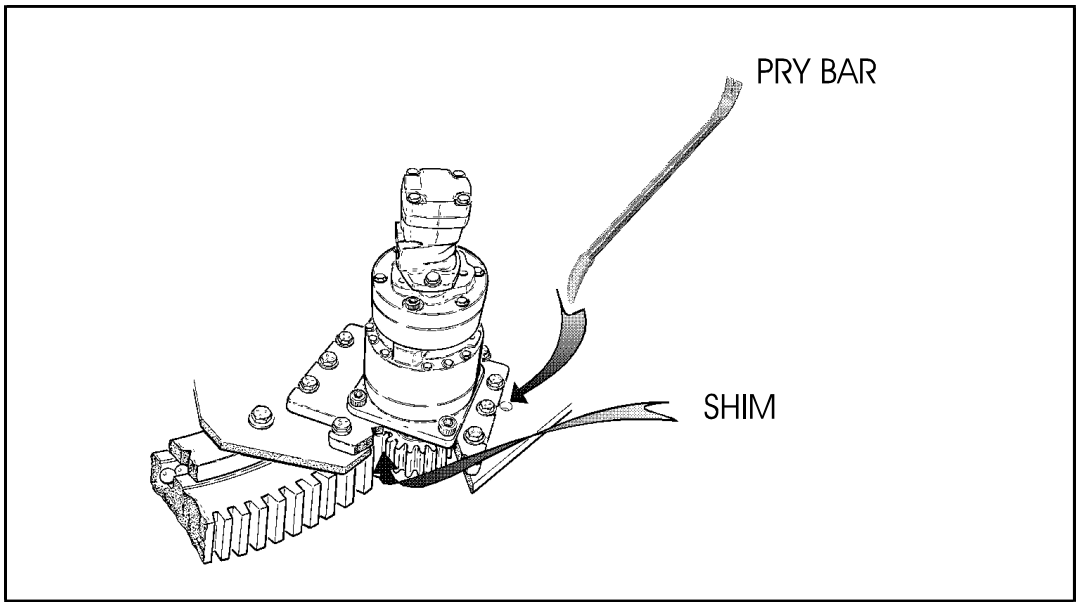


Figure 3-11. Swing Torque Hub Adjustment

3.9 SWING HUB

Adjustment Procedures

1. Ensure swing drive is located on bearing gear max eccentric tooth (high spot).
2. With mounting free to slide, shim between pinion and bearing gear teeth to achieve 0.008 - 0.012 backlash.
3. Install a pry bar into hole in turntable base plate and pry swing hub back tight against shim and bearing.
4. Torque bolts according to the torque chart in Section 1.

3.10 SWING BEARING

Turntable Bearing Mounting Bolt Condition Check

NOTE: *This check is designed to replace the existing bearing bolt torque checks on JLG Lifts in service. This check must be performed after the first 50 hours of machine operation and every 600 hours of machine operation thereafter. If during this check any bolts are found to be missing or loose, replace missing or loose bolts with new bolts and torque to the value specified in the torque chart, after lubricating the bolt threads with loctite #271. After replacing and retorquing bolt or bolts recheck all existing bolts for looseness.*

Check the frame to bearing. Attach bolts as follows:

1. Elevate the fully retracted boom to 70 degrees (full elevation).
2. At the positions indicated on Figure 3-12. try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.
3. Assure that the 0.0015" feeler gauge will not penetrate under the bolt head to the bolt shank.
4. Swing the turntable 90 degrees, and check some selected bolts at the new position.
5. Continue rotating the turntable at 90 degrees intervals until a sampling of bolts have been checked in all quadrants.

Check the turntable to bearing. Attach bolts as follows:

1. Elevate the fully retracted boom to 70 degrees (full elevation).
2. At the positions indicated on Figure 3-12. try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.
3. Lower the boom to horizontal and fully extend the boom.

4. At the position indicated on Figure 3-12. try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.

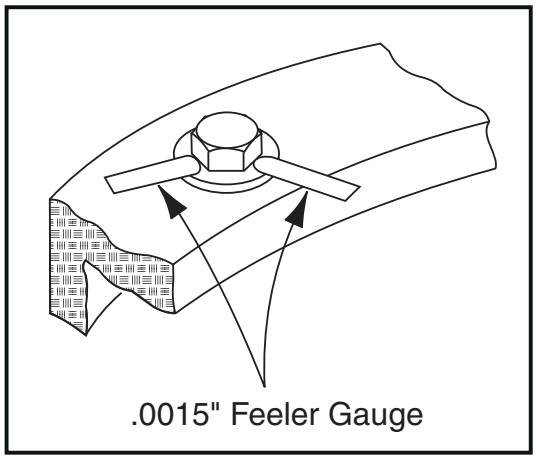


Figure 3-12. Swing Bearing Bolt Feeler Gauge Check

Wear Tolerance

1. From the underside of the machine, at rear center, with the boom fully elevated and fully retracted, as shown in (Figure 3-14., Swing Bearing Tolerance Boom Placement) A, using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. (Figure 3-13., Swing Bearing Tolerance Measuring Point)
2. At the same point, with the boom at horizontal and fully extended, and the tower boom fully elevated as shown in (Figure 3-14., Swing Bearing Tolerance Boom Placement) B, using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. (Figure 3-13., Swing Bearing Tolerance Measuring Point)
3. If a difference greater than 0.057 in. (1.40 mm) is determined, the swing bearing should be replaced.
4. If a difference less than 0.057 in. (1.40 mm) is determined, and any of the following conditions exist, the bearing should be removed, disassembled, and inspected for the following:
   a. Metal particles in the grease.
   b. Increased drive power required.
   c. Noise.
   d. Rough rotation.
5. If bearing inspection shows no defects, reassemble and return to service.

⚠ IMPORTANT

THE SWING BEARING IS ONE OF THE MOST CRITICAL POINTS ON AN AERIAL LIFT. IT IS HERE THAT THE STRESSES OF LIFTING ARE CONCENTRATED, AT THE CENTER OF ROTATION. BECAUSE OF THIS, PROPER MAINTENANCE OF THE SWING BEARING BOLTS IS A MUST FOR SAFE OPERATION.

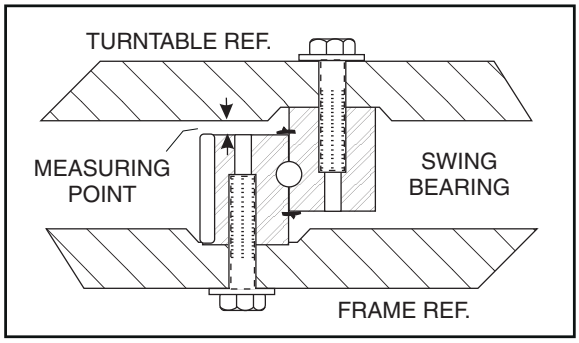


Figure 3-13. Swing Bearing Tolerance Measuring Point

Swing Bearing Replacement

1. Removal.
   a. From Ground Control station, operate the boom adequately to provide access to frame opening or, if equipped, to rotary coupling.

⚠ WARNING

NEVER WORK BENEATH THE BOOM WITHOUT FIRST ENGAGING BOOM SAFETY PROP OR PROVIDING ADEQUATE OVERHEAD SLING SUPPORT AND/OR BLOCKING.

   b. Attach an adequate support sling to the boom and draw all slack from sling. Prop or block the boom if feasible.
   c. From inside turntable, remove mounting hardware which attach rotary coupling retaining yoke brackets to turntable.

⚠ IMPORTANT

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID THE ENTRY OF CONTAMINANTS INTO THE SYSTEM.

   d. Tag and disconnect the hydraulic lines from the fittings on the top of the rotary coupling. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.

e. Attach suitable overhead lifting equipment to the base of the turntable weldment.

f. Use a suitable tool to scribe a line on the inner race of the swing bearing and on the underside of the turntable. This will aid in aligning the bearing upon installation. Remove the bolts and washers which attach the turntable to the bearing inner race. Discard the bolts.

g. Use the lifting equipment to carefully lift the complete turntable assembly from the bearing. Ensure that no damage occurs to the turntable, bearing or frame-mounted components.

h. Carefully place the turntable on a suitably supported trestle.

i. Use a suitable tool to scribe a line on the outer race of the swing bearing and the frame. This line will aid in aligning the bearing upon installation. Remove the bolts and washers which attach the outer race of the bearing to the frame. Discard the bolts. Use suitable lifting equipment to remove the bearing from the frame, then move the bearing to a clean, suitably supported work area.

2. Installation.

a. Using suitable lifting equipment, carefully lower the swing bearing into position on the frame. Ensure the scribed line of the outer race of the bearing aligns with the scribed line on the frame. If a new swing bearing is used, ensure that the filler plug fitting is at 90 degrees from the fore and aft center line of the frame.

⚠ CAUTION

JLG INDUSTRIES RECOMMENDS THAT ALL REMOVED BEARING BOLTS BE DISCARDED AND REPLACED WITH NEW BOLTS. SINCE THE SWING BEARING IS THE ONLY STRUCTURAL LINK BETWEEN THE FRAME AND TURNTABLE, IT IS IMPERATIVE THAT SUCH REPLACEMENT HARDWARE MEETS JLG SPECIFICATIONS. USE OF GENUINE JLG HARDWARE IS HIGHLY RECOMMENDED.

b. Apply a light coating of Loctite #271 to the new bearing bolts, and loosely install the bolts and washers through the frame and outer race of bearing.

⚠ CAUTION

IF COMPRESSED AIR OR ELECTRICALLY OPERATED IMPACT WRENCH IS USED FOR TIGHTENING THE BEARING ATTACHMENT BOLTS, THE TORQUE SETTING ACCURACY OF THE TOOL SHOULD BE CHECKED PRIOR TO USE.

c. Refer to the Figure 3-15., Swing Bearing Torque Sequence. Swing Bearing Torquing Sequence. Spray a light coat of Safety Solvent 13 on the new bearing bolts. Then apply a light coating of Loctite #271 to the new bearing bolts, and install the bolts and washers through the frame and outer race of the bearing. Tighten the bolts to an initial torque of 240 FT. LBS. (326 Nm) w/ Loctite.

d. Remove the lifting equipment from the bearing.

e. Using suitable lifting equipment, carefully position the turntable assembly above the machine frame.

f. Carefully lower the turntable onto the swing bearing, ensuring that the scribed line of the inner race of the bearing aligns with scribed line on the turntable. If a new swing bearing is used, ensure that the filler plug fitting is at 90 degrees from the fore and aft center line of the turntable.

g. Spray a light coat of Safety Solvent 13 on the new bearing bolts. Then apply a light coating of Loctite #271 to the new bearing bolts, and install the bolts and washers through the turntable and inner race of the bearing.

h. Following the Torque Sequence diagram shown in Figure 3-15., Swing Bearing Torque Sequence, tighten the bolts to a torque of 240 ft. lbs. (326 Nm) w/Loctite.

i. Remove the lifting equipment.

j. Install the rotary coupling retaining yoke brackets, apply a light coating of Loctite #242 to the attaching bolts and secure the yoke to the turntable with the mounting hardware.

k. Connect the hydraulic lines to the rotary coupling as tagged prior to removal.

l. At ground control station, use boom lift control to lower boom to stowed position.

m. Using all applicable safety precautions, activate the hydraulic system and check the swing system for proper and safe operation.

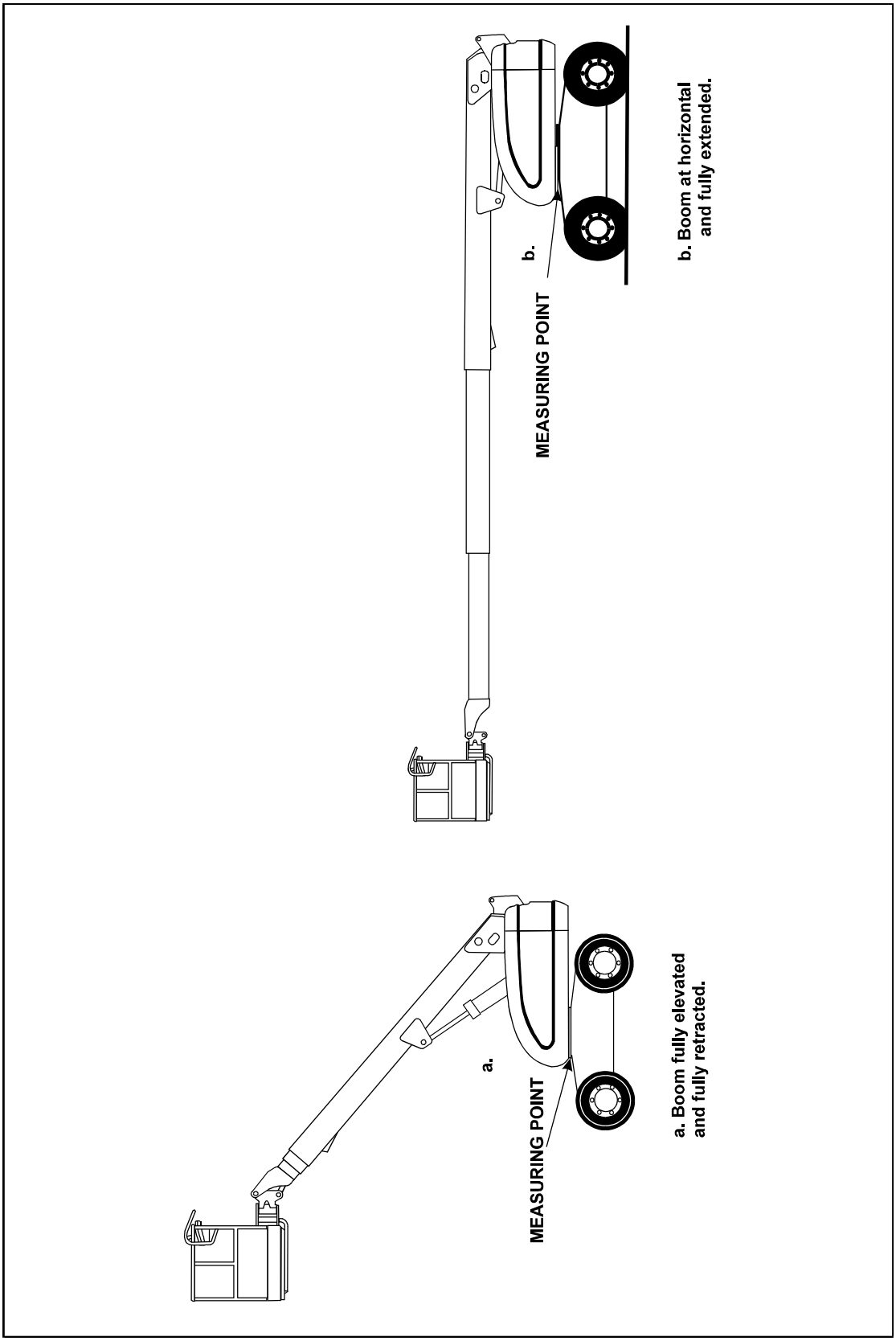


Figure 3-14. Swing Bearing Tolerance Boom Placement

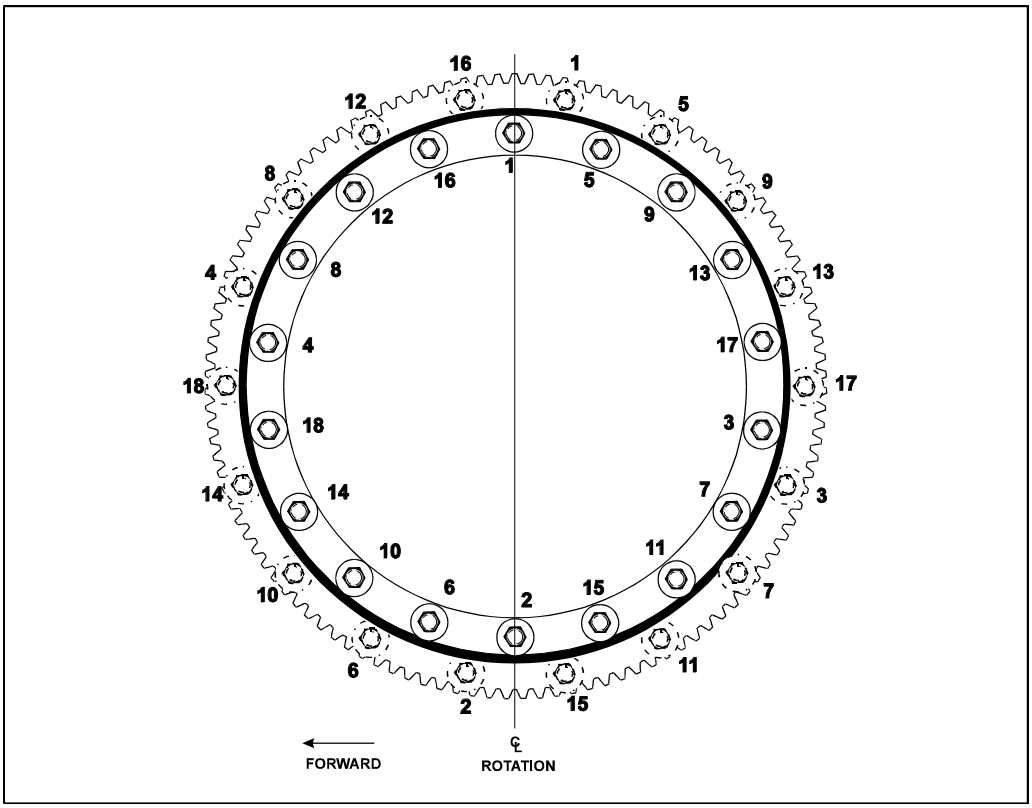


Figure 3-15. Swing Bearing Torque Sequence

Swing Bearing Torque Values

1. Outer Race - 240 ft. lbs. (326 Nm) w/Loctite, 220 ft. lbs. (298 Nm) dry.
2. Inner Race - 240 ft. lbs. (326 Nm) w/Loctite, 220 ft. lbs. (298 Nm) dry.
3. See Swing Bearing Torquing Sequence.

⚠ WARNING

CHECK THE INNER AND OUTER SWING BEARING BOLTS FOR MISSING OR LOOSENESS AFTER FIRST 50 HOURS OF OPERATION, AND EVERY 600 HOURS THEREAFTER.

3.11 SWING BRAKE - AUSCO

Disassembly

1. With the shaft protrusion downward, disassemble the parts in the following order; bolts (24) alternately, washers (23), power plate (21), and gasket.
2. Remove the following parts; stationary discs (14), rotating discs (12), primary disc (11), torque pins (3), springs (8&9), and the spring retainer (7).

NOTE: *If the bearing and seal are removed for any reason both must be replaced.*

3. Further disassembly is not recommended and should not be attempted unless necessary to replace the bearing (4), the seal (6), or the shaft (10). If further disassembly is needed, proceed as follows;
   a. The shaft (10) may be removed by pressing on the end of the shaft with a shop press.
   b. Using an appropriate tool, pry the seal (6) out from the inside of the brake. Take care not to damage the bore. Remove the retaining ring (5). Tap the bearing (4) out with a plastic mallet.

4. Remove the piston (15) from the power plate (21) by introducing low pressure air into the hydraulic inlet and make sure the piston is directed away from the operator. Remove the o-rings (17&19) and backup rings (16 & 18) from the piston O.D. and I.D. grooves. Do not remove backup rings (16 & 18) unless replacement is necessary because they will be damaged.With shaft protrusion downward, remove end cover (13) by removing capscrews (12).

Inspection

1. Clean all parts thoroughly.
2. Closely inspect all parts for excessive wear, cracks and chips. Replace parts as necessary.
3. Discard seals and o-rings.
4. Closely inspect bearings and bearing contact surfaces. Replace as necessary.

Assembly

⚠ IMPORTANT

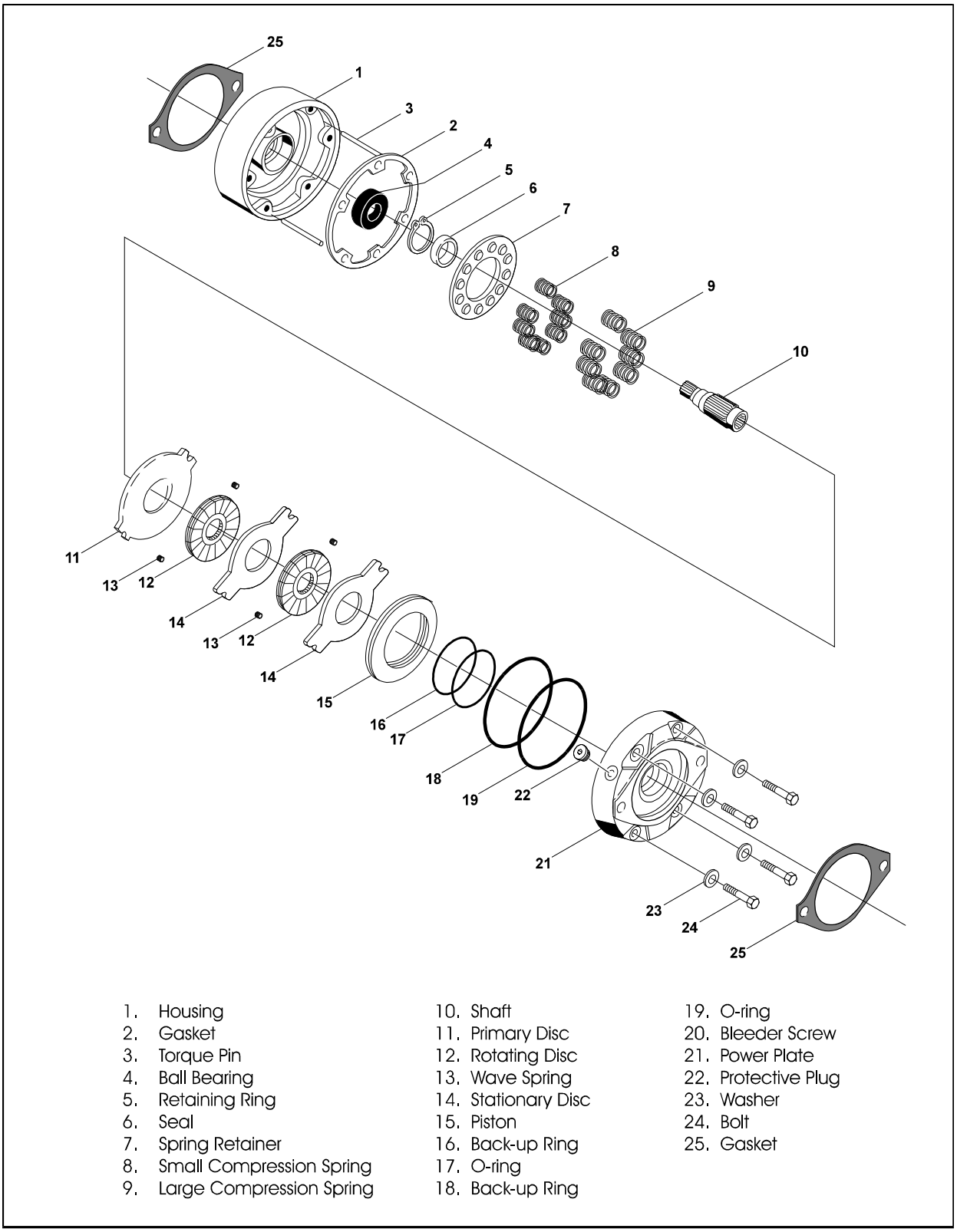
THERE MAY BE MORE PARTS IN A SERVICE KIT THAN YOUR BRAKE REQUIRES. CHECK THE PARTS LIST CAREFULLY FOR THE EXACT QUANTITY. IN THE CASE OF SPRINGS, SPACE THE SPRINGS AS SHOWN IN THE FIGURE.

1. Worn o-rings and damaged or worn Teflon backup rings must be replaced prior to assembly.
2. The cylinder of the power plate, piston, and o-rings must be clean prior to assembly and pre-lubed with the system hydraulic fluid.

⚠ CAUTION

THE DEPTH THE PISTON IS INSTALLED INTO THE POWER PLATE IS CRITICAL. THE SURFACE OF THE PISTON AT THE CUTOUTS MUST BE FLUSH TO 0.120 IN BELOW THE SURFACE OF THE POWER PLATE. DO NOT EXCEED THE 0.120 DEPTH OR THE PISTON WILL COCK RESULTING IN A COMPLETE LOSS OF BRAKING.

3. Assemble the piston (15) into the power plate (21) using a shop press, being careful not to damage the o-rings or Teflon back-up rings. Visually align the center of the cutouts in the piston with the torque pin (3) holes in the power plate (21).
4. For replacement of the seal;
   a. Use a shop press to install the bearing (4) into the housing. Press on the outer surface of the bearing only. Install the retaining ring (5) into the groove.
   b. Press the seal (6) into the housing (1) until it is flush with the face of the housing. The lip of the seal must face towards the bearing.
5. Press the shaft into the housing until it stops on the bearing. Support the inner race of the bearing during the press operation.
6. Rotating discs must be clean and dry. The lining material and mating surfaces of the stationary discs must be thoroughly clean and free of debris. Worn or scored rotating discs must be replaced.
7. Install bolts (24) with washers (23) in the power plate (21). Tighten sequentially, one turn at time, until the power plate is properly seated. Torque 105 to 115 foot-pounds.



1. Housing
2. Gasket
3. Torque Pin
4. Ball Bearing
5. Retaining Ring
6. Seal
7. Spring Retainer
8. Small Compression Spring
9. Large Compression Spring
10. Shaft
11. Primary Disc
12. Rotating Disc
13. Wave Spring
14. Stationary Disc
15. Piston
16. Back-up Ring
17. O-ring
18. Back-up Ring
19. O-ring
20. Bleeder Screw
21. Power Plate
22. Protective Plug
23. Washer
24. Bolt
25. Gasket

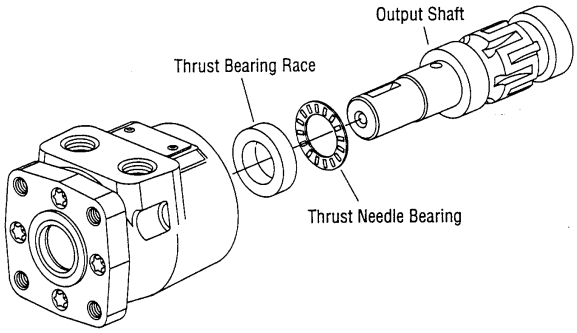
Figure 3-16. Swing Brake Assembly (Ausco)

3.12 SWING MOTOR

Cleanliness is extremely important when repairing hydraulic motors. Work in a clean area. Before disconnecting the hydraulic lines, clean the port area of the motor. Before disassembly, drain oil from the motor. Then plug the ports and thoroughly clean the exterior of the motor. Check the output shaft, remove any burrs, nicks, or sharp edges.

Disassembly

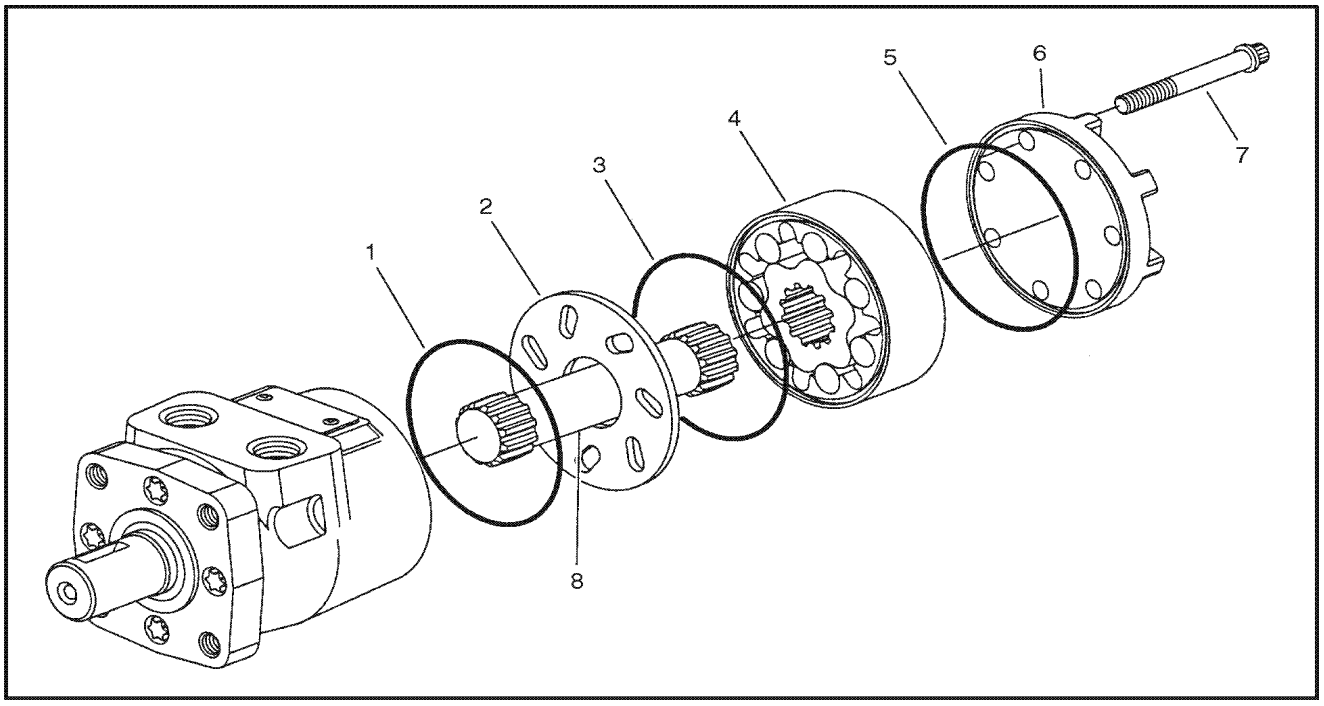
1. Clamp the motor in a vise so the shaft is vertical and the end cap is on the top. Clamp on the mounting flange, use just enough clamping force to hold the motor securely. Protect the mounting flange with soft vise jaws.
2. Remove the 7 cap screws from the end cap and disassemble the motor as shown.
3. Unclamp the motor and remove the output shaft, thrust needle bearing, and thrust bearing race.
4. Clamp the motor in a vise so the mounting flange is on top.Clamp across the port area. **Do not clamp on motor housing.** Use just enough clamping force to hold the motor securely.



5. Remove the four cap screws that hold the mounting flange to the motor housing.

⚠ CAUTION

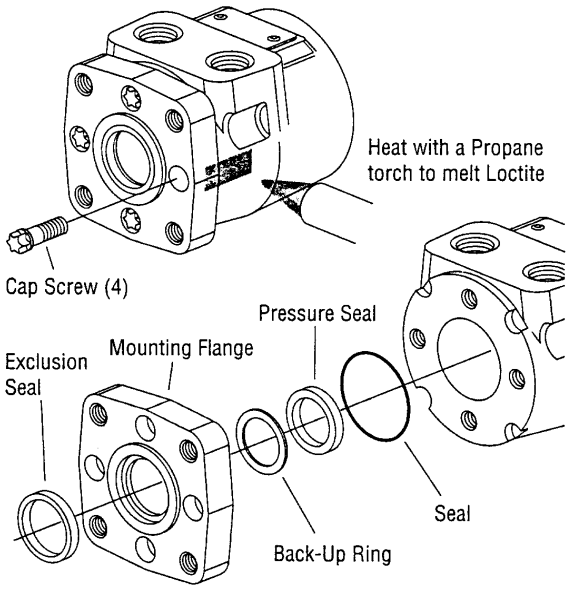
THESE SCREWS WERE LOCTITED DURING ASSEMBLY. DO NOT EXCEED 500 IN. LBS (56 NM) OF REMOVAL TORQUE



1. Seal
2. Spacer Plate
3. Seal
4. Geroler
5. Seal
6. End Cap
7. Capscrew
8. Drive

Figure 3-17. End Cap Removal

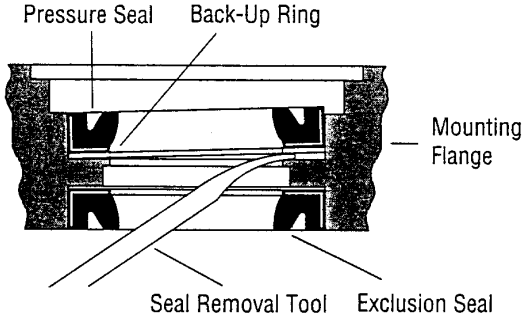
If the Loctite is holding the screws too tightly, heat the motor housing, with a propane torch, while turning screw. Apply heat to where the screw threads into the motor housing. Apply just enough heat to remove screw, do not over heat the motor housing or mounting flange.



6. Remove the mounting flange from the motor housing. The exclusion seal, pressure seal, and back - up ring will come off with the mounting flange.
7. Carefully remove the exclusion seal, pressure seal, and back - up ring from the mounting flange. A seal removal tool may be fabricated by bending and rounding the end of a small blade screwdriver.

⚠ IMPORTANT

DO NOT DAMAGE THE MOUNTING FLANGE WHERE THE SHAFT PASSES THROUGH IT.



Reassembly

Check all mating surfaces. Replace any parts with scratches or burrs that could cause leakage. Wash all metal parts in clean solvent. Blow them dry with pressurized air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage. Check the key way and chamfered area of the output shaft; remove any nicks, burrs, or sharp edges that could damage the shaft seal during assembly.

NOTE: *Always use new seals when reassembling hydraulic motors.*

⚠ IMPORTANT

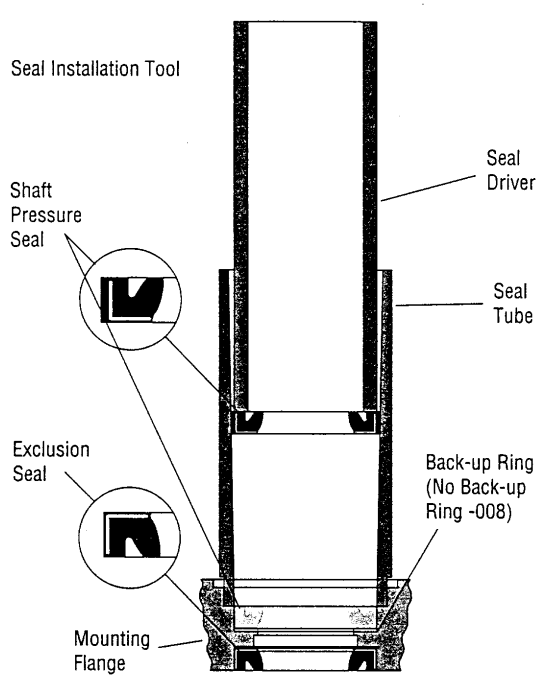
DURING REASSEMBLY LUBRICATE THE NEW SEALS WITH A PETROLEUM JELLY LIKE VASELINE. ALSO LUBRICATE MACHINED SURFACES AND BEARINGS WITH CLEAN HYDRAULIC FLUID.

1. Remove all of the old Loctite from the mounting flange cap screws and their threaded holes. The threads must be clean and dry for the new Loctite to hold properly.
2. Lubricate and install the output shaft, needle thrust bearing, and bearing race into the housing.

⚠ IMPORTANT

DO NOT PERMIT OIL TO GET INTO THE FOUR THREADED HOLES.

3. Lubricate the exclusion seal and press it into its seat in the mounting flange.
4. Lubricate and install the back - up ring and pressure. Use a seal installation tool to press the pressure seal into place.



⚠ IMPORTANT

BE SURE THE EXCLUSION SEAL AND PRESSURE SEAL ARE UNDAMAGED AND PROPERLY SEATED.

5. Clamp the motor in the vise so the output shaft is vertical and down. Clamp on the mounting flange.
6. Pour clean hydraulic fluid into the motor to provide start - up lubrication.
7. Lubricate and install one of the three largest diameter seals in the groove in the motor housing.
8. Install the drive.

NOTE: *If the splined ends of the Drive are different lengths, install the longer end into the shaft.*

Motor Timing

1. Align shaft timing dot with any bolt hole. Bolt hole will be used for timing reference.
2. Install spacer plate, and note the position of the threaded hole in housing aligned with the timing dot on shaft.

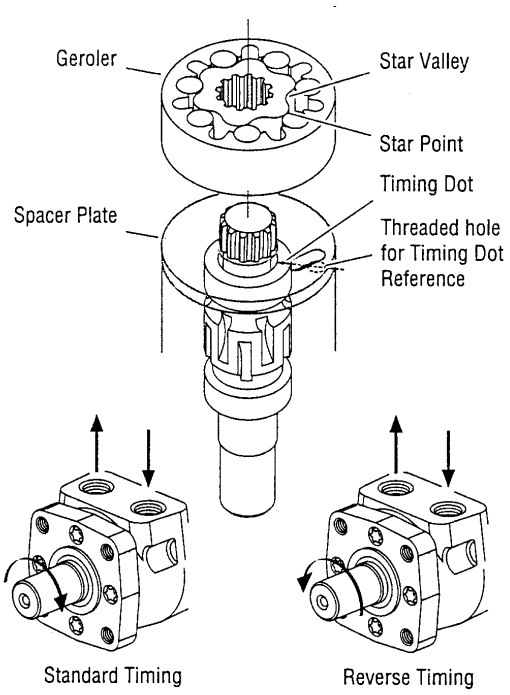
⚠ IMPORTANT

BE SURE THE SLOTS IN THE SPACER PLATE PROVIDE PASSAGE FOR HYDRAULIC FLUID AS WELL AS THE CAP SCREWS. IF THE SPACER PLATE IS FLIPPED THE MOTOR WILL NOT OPERATE.

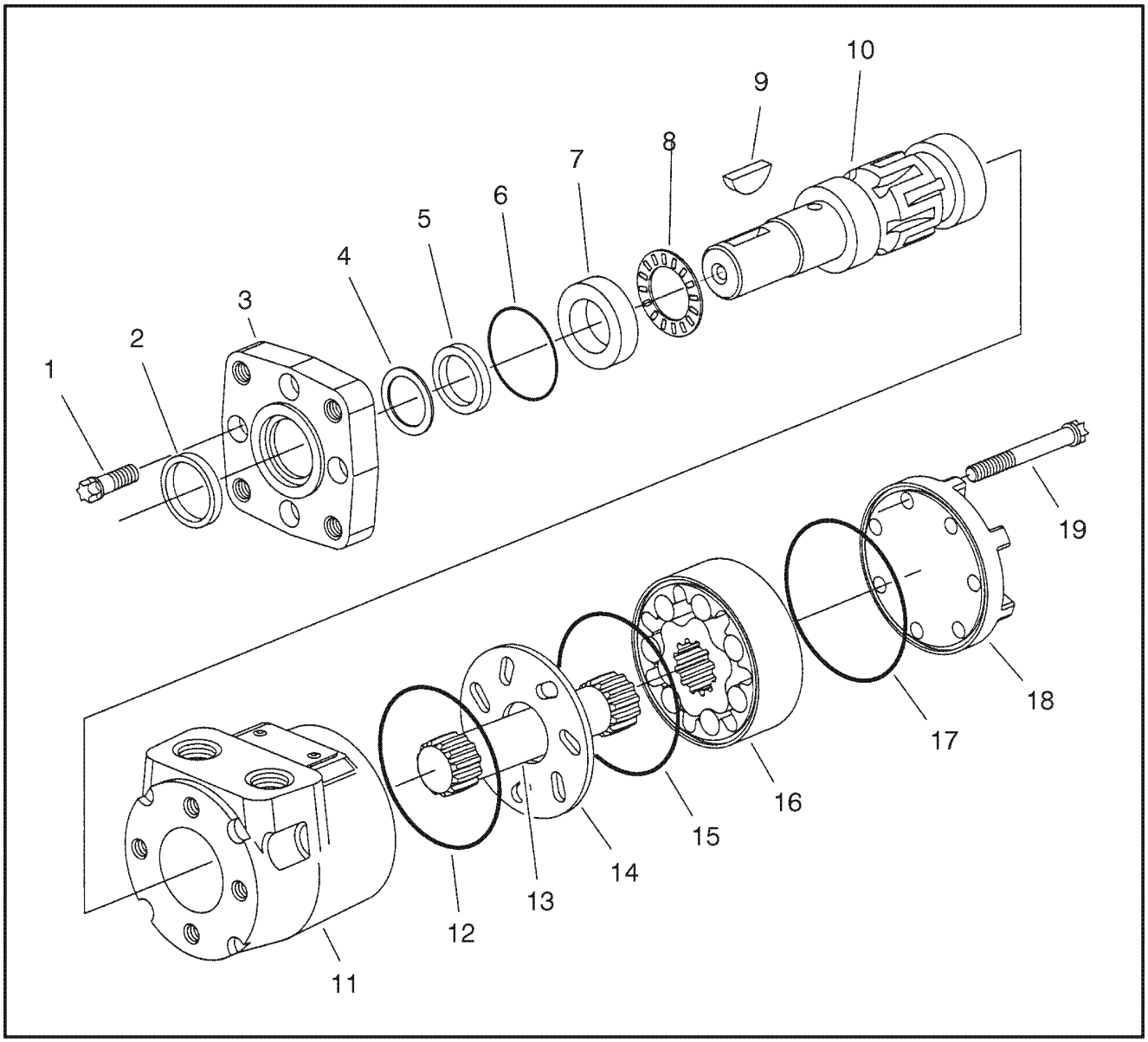
3. Lightly stretch, lubricate and install the second of the three larger diameter seals in the groove in the Geroler.

   Standard Timing: Align any star point with threaded hole noted for the location of the timing dot.

   Reverse Timing: Align any star valley with the threaded hole noted for the location of the timing dot.
4. Rotate the geroler to align the screw holes and install driver spacer if applicable.
5. Lubricate and install the last one of the three larger diameter seals in the groove in the end cap.
6. Install the end cap and seven cap screws.
7. Tighten the cap screws, in a criss - cross pattern, to 300 in lbs. (34 Nm).



8. The level down relief valve is located right next to the check port. Turn clockwise to increase and counterclockwise to decrease.



1. Capscrew
2. Exclusion Seal
3. Mounting Flange
4. Backup Ring
5. Pressure Seal
6. Seal
7. Bearing Race
8. Needle Thrust Bearing
9. Key
10. Output Shaft
11. Housing
12. Seal
13. Drive
14. Spacer Plate
15. Seal
16. Geroler
17. Seal
18. End Cap
19. Capscrew

Figure 3-18. Swing Motor

3.13 TILT ALARM SWITCH (MACHINES WITH EXTERNAL TILT SENSOR)

⚠ CAUTION

PERFORM TILT ALARM SWITCH LEVELING PROCEDURE A MINIMUM OF EVERY SIX MONTHS TO ENSURE PROPER OPERATION AND ADJUSTMENT OF SWITCH.

Manual Adjustment

1. Park the machine on a flat, level surface. Ensure machine is level and tires are filled to rated pressure.

NOTE: *Ensure switch mounting bracket is level and securely attached.*

2. Level the base of the indicator by tightening the three flange nuts through approximately one quarter of its spring travel. DO NOT ADJUST THE “X” NUT DURING THE REMAINDER OF THE PROCEDURE.
3. With the electrical connections complete, using bubble level on top of indicator, slowly tighten or loosen the three flange nuts until indicator is level.
4. Individually push down on one corner at a time; there should be enough travel to cause the switch to trip. If the switch does not trip in all three tests, the flange nuts have been tightened too far. Loosen the “X” nut and repeat steps (2). through (4).

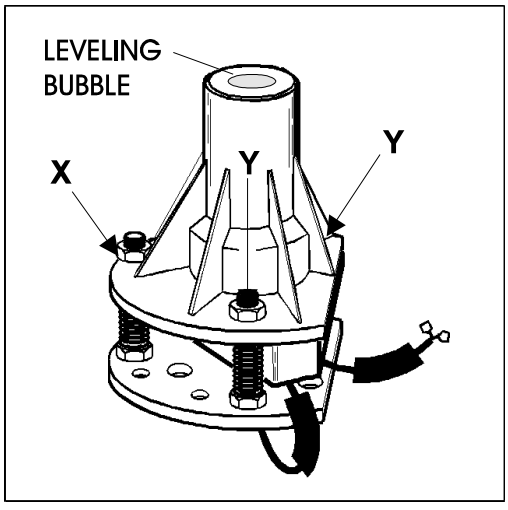


Figure 3-19. Tilt Switch Adjustment

3.14 SPARK ARRESTER CLEANING INSTRUCTIONS

1. Remove the cleanout plug in the bottom of spark arrester (muffler).
2. Without causing deformation (or any type of damage to the spark arrester) repeatedly tap on the arrester near the cleanout plug. This may be enough to begin drainage of the spark trap.
3. An industrial vacuum cleaner can do a complete job at this point.
   a. Or, IN A SAFE AREA, start the engine. Then alternate between low idle and high idle for two to three minutes.
   b. Or, operate the engine as required by the application for two to three minutes.
4. Install the cleanout plug. (See Table 2-4. Preventive Maintenance and Inspection Schedule.

3.15 DUAL FUEL SYSTEM

⚠ CAUTION

IT IS POSSIBLE TO SWITCH FROM ONE FUEL SOURCE TO THE OTHER WITHOUT ALLOWING THE ENGINE TO STOP. EXTREME CARE MUST BE TAKEN AND THE FOLLOWING INSTRUCTIONS MUST BE FOLLOWED.

Changing from Gasoline to LP Gas

1. Start the engine from the ground control station.
2. Open the hand valve on the LP gas supply tank by turning counterclockwise.

⚠ CAUTION

BE SURE ALL GASOLINE IS EXHAUSTED BEFORE SWITCHING TO LP GAS.

3. While the engine is operating, place the three position LPG/Gasoline switch at the ground control station to the center “off” position. Allow the engine to operate without load, until the engine begins to “stumble” from lack of gasoline.
4. As the engine begins to “stumble”, place the switch to the LPG position, allowing the LP fuel to be sent to the fuel regulator.

Changing from LP Gas to Gasoline

1. With engine operating on LP under a no load condition, throw the LPG/Gasoline switch at the ground control station to the “Gasoline” position.
2. If engine “stumbles” because of lack of gasoline, place the switch to the LPG position until engine regains smoothness, then return the switch to the Gasoline position. Repeat as necessary until engine runs smoothly on gasoline.
3. Close the hand valve on the LP gas supply tank by turning clockwise.

3.16 ELECTRIC GOVERNOR INSTALLATION AND ADJUSTMENTS - FORD ENGINE

General

These instructions presume no electrical test equipment other than a multimeter for making the electrical measurements called for on the following pages. If no suitable meter is available, an inexpensive but adequate meter, part number 22-188 is available from any local Radio Shack store.

Many “governor problems” turn out to be installation problems, particularly in first-time applications. Careful attention to the directions provided will go far toward a successful installation made in the least amount of time.

Quick-start Installations

If you are experienced in installing and adjusting Electric Governor, follow these steps. Otherwise, refer to the more detailed instructions starting with “MOUNTING-ACTUATOR”.

1. Mount Actuator rigidly to engine location which will permit a short, straight linkage to the carburetor or fuel valve. Avoid very hot areas.
2. Mount controller in a dry, fairly cool location. Accessibility for adjusting is required.
3. Wire per appropriate included schematic, using #16 wire.
4. Set up fuel linkage. This is critical, so review the section titled “LINKAGE”.
5. Hold linkage for safety, and start engine.
6. Adjust engine speed to desired valve using High Engine pot. Turn CW to increase, CCW to decrease speed. (See diagram on page 43 E-331 Electronics - Adjustment Locations.)

Mounting-Actuator

The Actuator may be mounted in any attitude — there is no preferred orientation.

With no power applied, the Actuator is spring-loaded to the minimum fuel position. The Actuator output shaft rotates toward the maximum fuel position against this spring through electrical power from the controller. This rotation is CW (clockwise) on one side of the Actuator, and CCW (counterclockwise) on the other. If necessary, reverse the Actuator on its mounting plate so that the desired direction of rotation is on the desired side to match the fuel system direction of travel.

Before selecting the mounting location, consider the linkage that will be required to connect the Actuator output arm to the butterfly or fuel valve. Read the following section on linkages before deciding on a mounting location!

Mount Actuator rigidly to engine location which will permit a short, straight linkage to the carburetor or fuel valve. Avoid very hot areas.

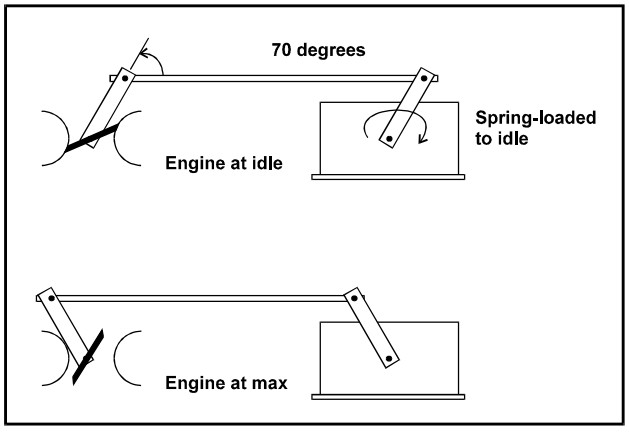
Linkage

1/4" -28 threaded rod and low friction rod-end bearings are recommended for linkage materials.

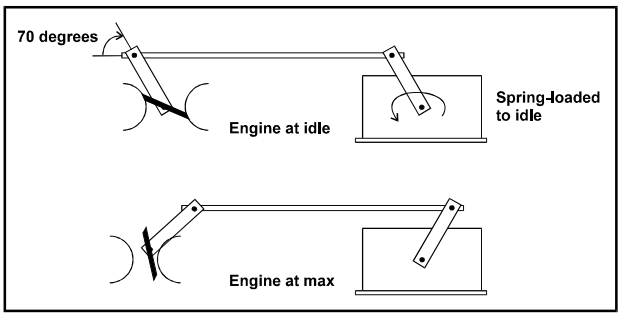
Keep the linkage as short and as straight as possible.

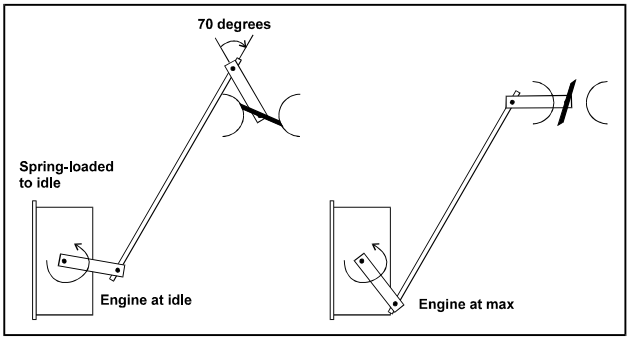
The linkage must not rub against the engine, brackets, hoses, etc. The linkage must be free of friction and lost motion or “slop”.

The following sketch indicates the proper linkage geometry for most installations.



Note that the angle between the carburetor arm and the rod is 70 degrees with the engine at idle. This is highly desirable! Note also that the Actuator arm travels equally on either side of a 90 degree angle with the rod. This angular arrangement will give the proper mechanical gain for good stability and performance. It may be necessary to rotate the carburetor arm relative to the butterfly to achieve this. This can usually be done, and is usually worth the effort! Below are some workable installations,





with good linkages. Remember, the Actuator can be turned 180 degrees on its mounting to “reverse” the spring-loaded direction. Also, the Actuator can be mounted in any attitude.

The needed travel of the carburetor determines how far out on the Actuator arm the rod is to be attached. In most cases, the carburetor should be moved from closed to above 10 degrees from full open as the Actuator is moved min. to max. THEN ALTER THE LENGTH OF THE ROD SLIGHTLY (PERHAPS 0.030"), SO THAT THE ACTUATOR IS JUST OFF ITS INTERNAL STOP, AND IS PULLING THE BUTTERFLY AGAINST ITS STOP. This insures that the carburetor can fully close to idle on load dumps, minimizing overspeeds.

Examine the system for springs, such as carburetor return springs. These should be removed. Some automotive carburetors (as opposed to industrial carburetors) contain internal springs for accelerator pumps, ect. These may make good governing difficult, or even impossible. For this, and other reasons, industrial carburetors are much to be preferred.

Move the linkage slowly through its travel, and look for any binding or unexplained forces. Correct any before going further.

Many “governing” problems are really caused by binding of the butterfly and its shaft in the carburetor. This is caused by loading due to vacuum under the butterfly and atmospheric pressure above when the engine is running. These forces cannot be felt when the engine is not running. Therefore, start the engine while carefully controlling the speed by hand, and feel for binding or airload forces. Needle bearings on the butterfly shaft are available on many industrial carburetors to deal with this problem. Any tendency on the butterfly stick must be corrected.

Mounting-Controller

Select a reasonably cool, dry, and vibration free location.

The rear cover will probably need to be removed during set-up in order to make adjustments for speed setting and gain. You may wish to defer final installation until this is done.

After completing these adjustments, replace cover. Mount so that water cannot pool on this cover. Always mount the controller with the strain relief down. This will prevent water from entering thru the cable, also place the vent hole in the bottom of the controller down.

Wiring

See wiring diagram for details of hook-up.

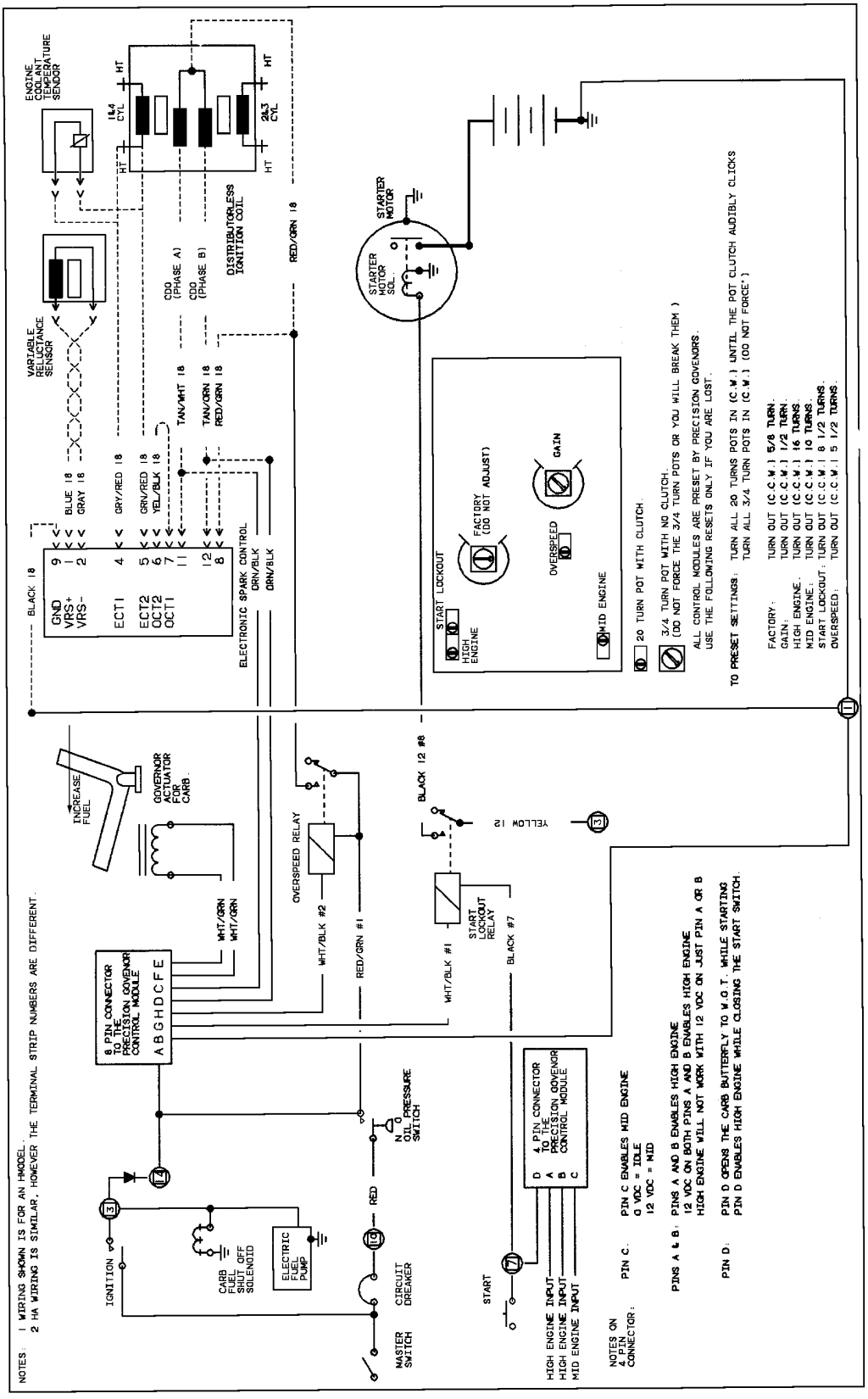
Use #16 wire minimum.

Keep all wiring to the Governor as short as is practical.

Go directly from the controller ground terminal (B of the 8 pin connector) by dedicated wire, to the battery “minus” terminal. If this cannot be done, for some reason, go by dedicated wire to a very good engine ground.

A properly functioning engine electrical system will supply 13.5 - 14.8 VDC when the engine is running. If wiring size is adequate, with good connections and proper grounds, you will get this reading between the wires terminals A & B of the 8 pin connector when the Governor is controlling engine speed. Verify this.

Improper hook-up can damage electronics. Re-check wiring before applying power.


NOTES: 1 WIRING SHOWN IS FOR AN HMODEL.
2 HA WIRING IS SIMILAR, HOWEVER THE TERMINAL STRIP NUMBERS ARE DIFFERENT.
BLACK 18
GND 9
VRS+ 1
VRS- 2
BLUE 18
GRAY 18
ECT1 4
ORY/RED 18
ECT2 5
OCT2 6
OCT1 7
ORN/RED 18
YEL/BLK 18
11
12
8
TAN/WHT 18
TAN/ORN 18
RED/ORN 18
CDD (PHASE A)
CDD (PHASE B)
DISTRIBUTORLESS IGNITION COIL
RED/ORN 18
ELECTRONIC SPARK CONTROL
ORN/BLK
ORN/BLK
VARIABLE RELUCTANCE SENSOR
ENGINE COOLANT TEMPERATURE SENSOR
1&4 CYL
2&3 CYL
HT
HT
HT
HT
STARTER MOTOR
STARTER MOTOR SOL.
START LOCKOUT
HIGH ENGINE
FACTORY (DO NOT ADJUST)
OVERSPEED
GAIN
MID ENGINE
20 TURN POT WITH CLUTCH
3/4 TURN POT WITH NO CLUTCH
(DO NOT FORCE THE 3/4 TURN POTS OR YOU WILL BREAK THEM)
ALL CONTROL MODULES ARE PRESET BY PRECISION GOVERNORS.
USE THE FOLLOWING RESETS ONLY IF YOU ARE LOST.
TO PRESET SETTINGS: TURN ALL 20 TURNS POTS IN (C.W.) UNTIL THE POT CLUTCH AUDIBLY CLICKS
TURN ALL 3/4 TURN POTS IN (C.W.) (DO NOT FORCE')
FACTORY: TURN OUT (C.C.W.) 5/8 TURN.
GAIN: TURN OUT (C.C.W.) 1/2 TURN.
HIGH ENGINE: TURN OUT (C.C.W.) 16 TURNS.
MID ENGINE: TURN OUT (C.C.W.) 10 TURNS.
START LOCKOUT: TURN OUT (C.C.W.) 8 1/2 TURNS.
OVERSPEED: TURN OUT (C.C.W.) 5 1/2 TURNS.
INCREASE FUEL
GOVERNOR ACTUATOR FOR CARB
8 PIN CONNECTOR TO THE PRECISION GOVENOR CONTROL MODULE
A B G H D C F E
WHT/GRN
WHT/GRN
OVERSPEED RELAY
WHT/BLK #2
RED/GRN #1
BLACK 12 #8
YELLOW 12
WHT/BLK #1
START LOCKOUT RELAY
BLACK #7
N.O. OIL PRESSURE SWITCH
RED
CIRCUIT DREAMER
MASTER SWITCH
IGNITION
CARB FUEL SHUT OFF SOLENOID
ELECTRIC FUEL PUMP
START
HIGH ENGINE INPUT
HIGH ENGINE INPUT
MID ENGINE INPUT
D 4 PIN CONNECTOR TO THE A PRECISION GOVENOR B CONTROL MODULE C
NOTES ON 4 PIN CONNECTOR:
PIN C. PIN C ENABLES MID ENGINE
0 VDC = IDLE
12 VDC = MID
PINS A & B: PINS A AND B ENABLES HIGH ENGINE
12 VDC ON BOTH PINS A AND B ENABLES HIGH ENGINE
HIGH ENGINE WILL NOT WORK WITH 12 VDC ON JUST PIN A OR B
PIN D: PIN D OPENS THE CARB BUTTERFLY TO W.O.T. WHILE STARTING
PIN D ENABLES HIGH ENGINE WHILE CLOSING THE START SWITCH.

Check-Out and Initial Start-Up Procedures

Before proceeding, familiarize yourself with the locations of the various adjustment pots. There are two types of adjustment pots.

Multi-Turn Adjustment (High Engine, Mid Engine, Overspeed, Starter Lockout)

This adjustment is made by turning the 1/8" brass screw clockwise (CW) to increase speed, and counterclockwise (CCW) to decrease speed. The adjustment range of the pot is 25 turns, and one full turn will change speed about 100-200 rpm. This pot is protected by a slip clutch at each end, and will not be harmed by moderate over-adjustment. However, the Governor will not function while the pot is past full travel. If you suspect you may have over-adjusted the High Engine pot, or have lost track of where you are, turn the pot 25-30 turns CCW, then back 10-12 turns CW to get back into the range of normal adjustment.

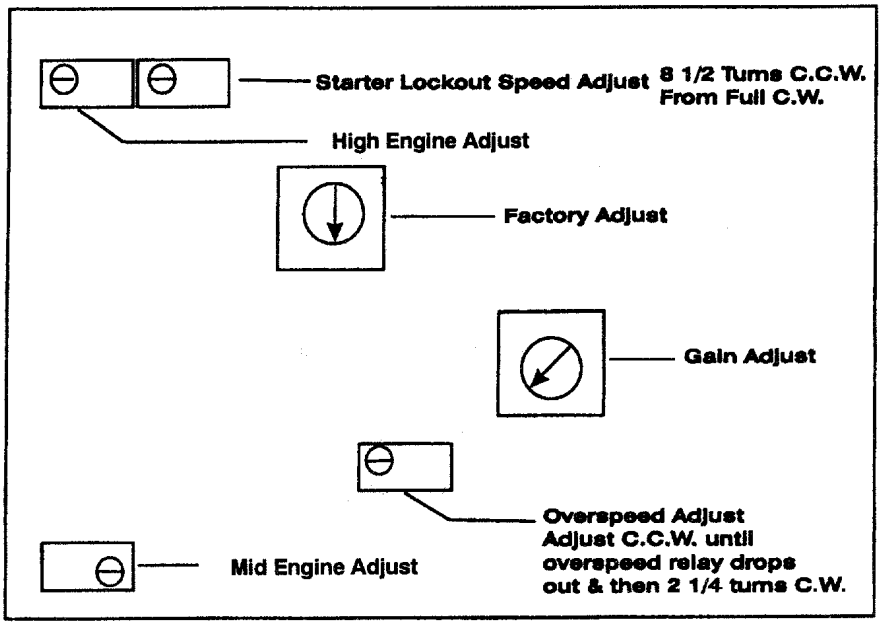
Single-Turn Adjustment (Gain, Factory Adjust)

This pot is 3/8" square and has a 1/8" plastic screw in its center. Be gentle! This pot turns 270 degrees, and over-turning will break the internal stops, making adjustment impossible. Turning this pot CW increase Governor sensitivity. On most applications, best operation is achieved with the pot set as shown in diagram below.

NOTE: *These settings are factory set, Start Lockout, Factory Adjust and Overspeed. They are conformally coated by P.G. and should not need to be reset.*

Assuming that the Actuator and Controller are mounted, the wiring is run and checked, and that the linkage is properly installed, proceed as follows:

Part No. 1600211



Connections

A Power
B Ground
C Ignition Signal
D Ignition Signal
E Actuator
F Actuator
G Starter Relay GND
H Overspeed Relay GND

A Elevation Switch
B Drive Control Switch
C Mid-Speed Switch
D Starter Switch

Set Main Speed Before Setting Overspeed

Directional arrows ⊘ Indicate normal settings.

1. Turn ignition switch on. Do not start engine. Actuator should kick toward max. fuel once, and then immediately return to min. fuel. If not, see Troubleshooting.
2. Use multimeter to check battery voltage at battery terminals, and record. Now check voltage at the machine connection points for terminals A & B of the 8 pin connector on the E-331 (A is +, B is -). Voltage reading should be the same as at battery. If not, shut down, and correct wiring.
3. Hold the linkage back by hand, so as to control engine speed manually. Start engine, set vehicle controls to obtain High Engine speed, gradually release the linkage, and adjust the speed-set as needed to set the speed as desired. If engine speed surges, reduce Gain a little, as required (CCW).
4. Re-check voltage between terminal A & B as in step 2. Voltage reading should be between 13.5 - 14.6 VDC.
5. Carefully adjust Gain. You are looking for the best compromise between quick response and good stability. Make very small adjustments, then load and unload engine, or pull linkage back slightly and release. Usually, a good set-up is one that makes 1 to 3 small bounces and then steadies down after a large change. Too much Gain shows up as a rapid (once per second) instability, most commonly at light loads. Too little Gain shows up in large overshoots on start-up or large load changes, and generally sluggish operation.
6. Make final adjustment to the High Engine Pot.
7. Set machine controls to obtain the mid-engine speed. Adjust the mid-engine pot as needed to obtain the speed desired.
8. The start lockout adjustment is factory set. If necessary, he starter lockout pot may be adjusted to obtain dropout of the starter as the engine attains running speed. Normally this is around 500 RPM.
9. The overspeed adjustment is factory set. If necessary, it may be readjusted to shut off ignition power at a different engine speed by means of the overspeed adjustment pot. The overspeed is simply to shut down an over revving engine.

NOTE: *Overspeed to be set at 4000 - 4500 RPM's. This is not a function we test for correct settings. The High Engine speed must be set before setting the overspeed.*

10. Re-install the back cover on the E-331. Final mount the controller.

Troubleshooting

We will discuss Troubleshooting in two general categories:

Governor won't work.

Governor works, but can't be set up to give satisfactory performance.

There is, of course, some overlap between these categories. Read both sections and apply the fixes that seem appropriate.

NOTE: *During troubleshooting, be prepared to control the engine manually to prevent overspeeds, etc.*

Governor won't work.

No reaction from Governor. Actuator output arm never moved, engine off or engine running. Can be caused by:

1. No power.
2. Incorrect linkage, preventing movement.
3. Incorrect electrical hook-up.
4. No speed signal to Governor.
5. Damaged Controller or Actuator.

1. **No power** - Use a multimeter to check for 12-15 VDC between terminals A & B on the controller. Check during engine off and engine running conditions. If voltage is absent or low, check for:
   a. Wiring error.
   b. Hook-up on wrong side of ballast resistor.
   c. Low battery.
   d. Bad voltage regulator.
   e. Bad ground connection.
   f. Corroded terminals.
   g. Undersized wiring.

2. **Incorrect Linkage** - Re-check linkage as discussed on page 40 and 41. Freedom of movement and lack of play are important.
3. Incorrect Electrical Hook-up - Re-check all wiring and connections to the Actuator and Controller against the supplied schematic.
4. No speed signal to Controller.
   a. Check the voltage between terminals C and ground and D and ground of the 8 pin connector with the engine running. You should see 5 - 30 VDC.
   b. The above checks do not guarantee a good speed signal, but their absence proves that there is a problem.
5. Incorrect Electrical Hook-up - If steps 1 - 4 above have not revealed the problem, the governor may have been damaged, either in shipping or during hook-up and test.

Governor reacts, but can't be set up to give proper performance.

This kind of trouble usually falls into three main categories:

1. Actual Governor malfunction.
2. Governor installation problems and improper installation.
3. Governor not tuned or adjusted for engine/application.

NOTE: *Assure the engine is operating properly by running engine manually. The Governor will not control any poor running engine.*

1. Actual Governor Malfunction - The Governor was engine-tested for proper operation just prior to being shipped. Unless damaged in shipment or by improper handing, it should be serviceable. To check for proper operation proceed as follows:
   a. Once again, disconnect fuel system linkage from Governor output arm and control engine manually.
   b. Start engine, hold at a low speed, Governor arm should move to full-fuel position.
   c. Increase engine speed carefully. At some engine speed, Governor arm should move to low-fuel position.
   d. By carefully varying engine speed, you should be able to cause the Governor arm to pause momentarily near the middle of its travel. This engine speed is the speed for which the Governor is adjusted. If grossly incorrect, reset High Engine Pot.
   e. With the engine running at low speed, move the Governor arm throughout its stroke by hand. You should feel a constant smooth force in the on direction. No binding or rubbing should be felt within the Governor.

If steps 1a. thru 1e. can be accomplished as described, the Governor is probably OK. It recognizes underspeed, overspeed, onspeed and is not binding internally.

If the above steps cannot be accomplished satisfactorily, there is probably an actual Governor malfunction.

2. Installation and adjustment problems.
   a. Governor is unable to move fuel system freely (not enough Actuator force available). If Governor doesn't move fuel system to on far enough to provide sufficient fuel but Governor arm moves far enough when disconnected look for:

      1.Linkage binding or misadjusted.

      2.Low voltage at Governor during operation.
      *Measure the voltage as discussed previously and observe voltage during operation. If Governor fails to move full on and voltage dips over 1 volt, check for undersize wire (should be #16 minimum).

      3.Excessive forces at Governor during running, particularly on carburetor engines.
      *Carburetor butterfly valves are loaded by engine vacuum during running, which can add considerable force not present when engine isn't running.
      *Springs in the system; carburetor return springs, acceleration pump springs, etc., are not usually needed and can cause governing problems.

b. Governor is unstable at light-load or no-load. See “Linkage” for carbureted engines.

c. Governor experiences sudden, momentary spikes toward max. at random intervals, then recovers.

1.Look for loose wiring or momentary shorts in wiring.

2.Noise or occasionally missing speed signal.

d. Speed seems to slowly wander (5-15 second periods) around at speed, particularly at higher loads. See item 2a. 3 concerning excessive forces at Governor during running.

3. Governor not tuned or adjusted for engine/application.

The basic adjustment to set sensitivity/stability is the Gain pot. A good starting point for many engines is full CCW, then CW 1/3 turn. (See “Governor adjustment” section). To increase stability, turn CCW. If satisfactory governing cannot be achieved with this one adjustment, the factory adjustment may be needed. Normal starting point for this adjustment is fully CCW, then CW 1/4 turn. (Before changing this pot, mark the original position).

NOTE: *If problems occurs with the Governor overshooting when a large load is released from the engine, such as driving up a hill and stopping. There is usually one of two things:*

1.Gain adjustment is too far CCW.

2.Mechanical preload between the carburetor and actuator is to large, this should be no greater than 1/2 to 1 ball dia.

3.17 THROTTLE CHECKS AND ADJUSTMENTS - DEUTZ ENGINE (PRIOR TO S/N 61306)

General

The throttle control system on the Deutz engine includes the positional controller and the actuator.

Four LEDs are incorporated in the controller. They are as follows:

- Red - failure: signals a problem with the system - needs service or adjustment
- Green - clutch engaged; operation normal while system is powered.
- Amber - motor extend
- Amber - motor retract

The controller is designed so that when the system voltage reaches 10.5 volts, the actuator clutch will be released and the motor drive turned off in order to prevent unpredictable operation from occurring.

When a failure condition occurs (i.e. position time-out) the controller will release the clutch and turn off the actuator motor. This will prevent unnecessary motor wear.

Table 3-1.Position Controller Truth Table

Control Wiring				Actuator Position
Black	Red	White	Green	
GND	OFF	X	X	OFF POSITION (Freewheel)
GND	+12 VDC	OFF	OFF	POSITION 1 (See Adjustments)
GND	+12 VDC	+12 VDC	OFF	POSITION 2 (See Adjustments)
GND	+12 VDC	OFF	+12 VDC	POSITION 3 (See Adjustments)
GND	+12 VDC	+12 VDC	+12 VDC	POSITION 4 (See Adjustments)

GND = POWER SUPPLY OR BATTERY GROUND
OFF = GROUND OR OPEN CIRCUIT
X = DON’T CARE
+12 VDC = +12 VOLT POWER SUPPLY OR BATTERY SYSTEM, VIA A 5 AMP FUSE OR CIRCUIT BREAKER

TRIMMER ADJUSTMENTS	LED INDICATORS
1 - POSITION 1 CW=RETRACT	R - RETRACT INDICATOR (AMBER)
2 - POSITION 2 CW=RETRACT	E - EXTEND INDICATOR (AMBER)
3 - POSITION 3 CW=RETRACT	C - CLUTCH INDICATOR (GREEN)
4 - POSITION 4 CW=RETRACT	F - FAILURE INDICATOR (RED)

Procedure

NOTE: *Never run fuel tank dry. Diesel engines cannot be restarted after running out of fuel until fuel system has been air-vented or bled of air. See Deutz Instruction Manual for procedure.*

1. Power the ignition switch at the ground control panel. Set the mid rpm.
2. Supply 12 volts of power to the white wire on the controller. Set the high engine rpm.

NOTE: *Actuator rod travel must stop slightly before lever makes contact with throttle lever stop. Failure to do so will burn out actuator.*

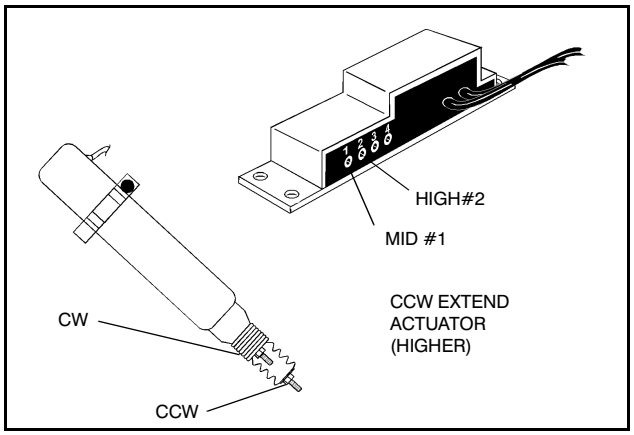
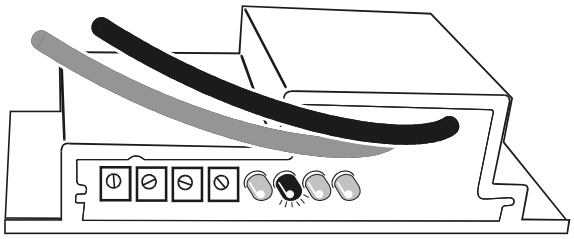


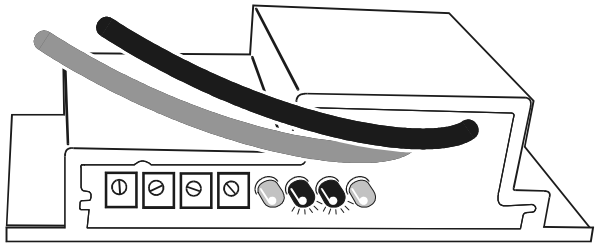
Figure 3-20. Addco Adjustments - Deutz

Controller Status

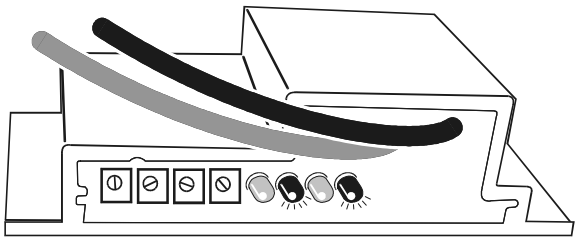
Clutch engaged no actuator movement



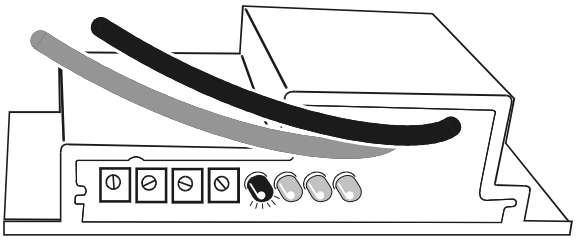
Clutch engaged actuator extending



Clutch engaged actuator retracting

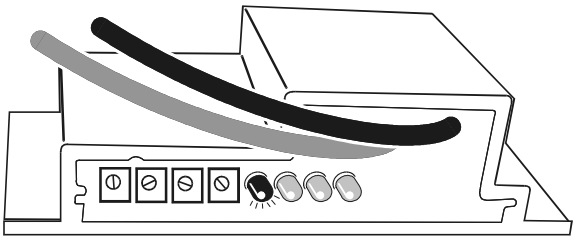


Controller fault - clutch disengaged and no actuator movement



Failure Modes

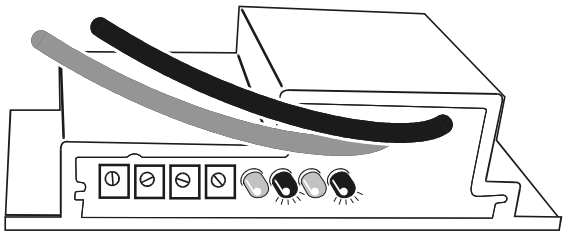
Immediate Red Light



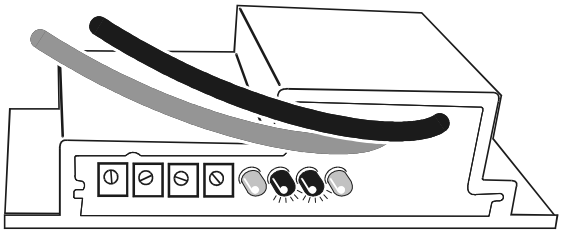
Action:

1. Recycle power to determine if the problem is intermittent.
2. The input voltage must be greater than 10.5 Vdc.
3. Check wiring for any damage and correct.
4. Disconnect engine harness and actuator connnections.
5. If problem reoccurs return unit.

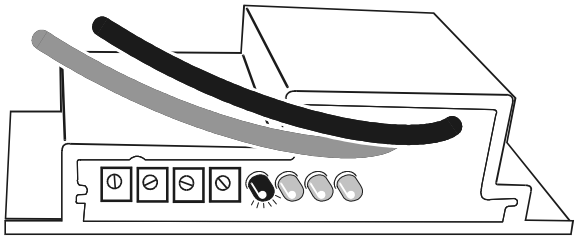
Green and either Amber light followed by a red light



or



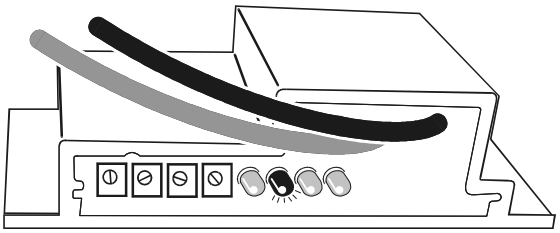
then



Action:

1. Inspect and clean wiring connections.
2. Examine throttle linkage for any damage or bent components and correct.
3. With linkage disconnected, check each potentiometer for operation.
4. Reconnect linkage and reset each potentiometer for correct operation.
5. If failure continues to occur, replace unit.

Only green light on and no actuator movement

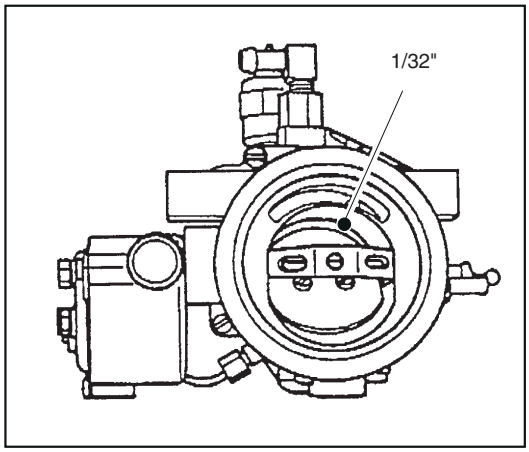


Action:

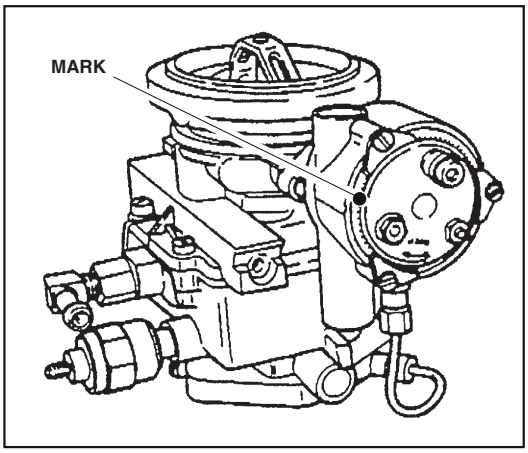
1. Adjust trim potentiometers.
2. If problem continues, replace unit.

3.18 AUTOMATIC CHOKE ADJUSTMENT - FORD ENGINE

1. At 70°F the choke plate should be open 1/32" (not touching the choke bore).
2. If the ambient temperature is not 70°F, an additional adjustment is required.
   a. Loosen the three cover plate screws.
   b. Adjust the cover to open the choke plate 1/32".



c. Readjust for ambient temperature by rotating the cover one (1) mark per 5°F from 70°F. Rotate CCW (lean) if warmer than 70°, CW (rich) if colder than 70°. (If actual temperature is 80°, set at 1/32" and rotate two (2) marks CCW [lean] direction.)



d. Tighten the three cover plate screws and check for free rotation (no sticking or binding) of the choke shaft.

3.19 COLD WEATHER STARTING DIFFICULTY

Machines equipped with carbureted Ford LRG-425 engines in weather conditions of 15 to 20° F (-9.5 to -6.5 C) or colder may encounter difficulty in starting.

After 10 unsuccessful attempts of starting the engine follow the troubleshooting procedures below to locate the cause of the starting difficulty.

Most Cold weather starting issues fall into the following categories which will be addressed separately:

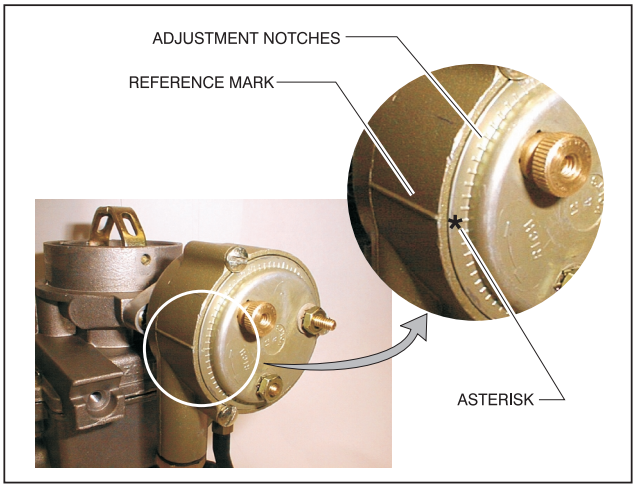
- Carburetor
- Ignition
- Fuel

1. **Engine Receiving Fuel** - After cranking the engine for a period of time, there may be white smoke noticed coming out of the exhaust tube. This is an indication that the engine is in a "flooded" condition. If the engine is flooded and will not start, follow the procedures under Checking the Carburetor. If after following those procedures the engine still does not start, continue with Checking the Ignition.
2. **Engine Not Receiving Fuel** - If after cranking the engine for a period of time, and there is no white smoke coming out of the exhaust tube, follow the procedures under Checking the Fuel.

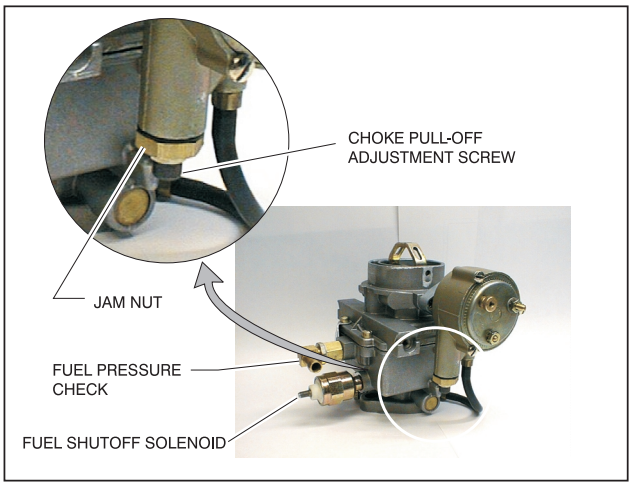
Checking the Carburetor

After cranking the engine for a period of time there may be white smoke noticed coming out of the exhaust tube. This is an indication the engine is receiving fuel and is in a “flooded” condition.

NOTE: *Make sure the choke is adjusted using the asterisk (*). There is also a zero (0) stamped on the choke. The zero (0) is used for assembly purposes and is not to be used as an adjustment reference.*



1. Check the choke for ambient temperature setting. The default ambient temperature setting is 70° F (21° C), which aligns the asterisk (*) on the choke face with the reference mark on the side of the choke housing. The choke should be set at one notch “clockwise” past the (*) asterisk for every 5 degrees below 70° F (one notch “clockwise” past the (*) asterisk for every 2.8 degrees below 21° C). This adjustment will "richen" the fuel mixture.
2. Check if the choke “butterfly” is stuck by manually opening and closing by hand.
3. Check the choke pull-off (butterfly stop) screw for proper adjustment as follows:



a. Loosen jam nut

b. Screw the adjustment screw all the way in, then back out 1/2 turn.

c. Tighten jam nut.

Try to start the engine.

NOTE: *If EMS switch is pulled on for an extended period of time, i.e. 1 to 2 minutes, without attempting to start the engine, the choke will start to open due to electrical heating.*

Checking the Ignition

If the engine tries to start but spits and sputters:

1. Check the Oil Pressure Switch:
   a. Check for voltage from N.C. (normally closed) terminal to common ground while cranking the engine. (what should the voltage be?)
   b. Jump all three posts at the oil pressure switch, then see if the engine will start.
   c. If the engine starts after jumping the posts, replace oil pressure switch (JLG p/n: 4360405)
2. Check the Spark Plugs for presence of spark. If there is no spark at the plugs during cranking:
   a. Overspeed relay not activating.
   b. Check the ignition module red/green wire for 12 volts.
   c. Check the white/black wire coming from the 8-pin connector (pin-H) that runs to the overspeed relay on terminal 85 for proper ground.
3. Ignition module may have failed.
   a. Ignition module series: AA, AB and FA prior to date code-1889 may need replaced. (refer to: Ford Technical Bulletin # FF-91-99)
   b. Check the vacuum advance tube attached to the ignition module for secure connection.

Try to start the engine.

3.20 CHECKING THE FUEL

The engine may not be getting fuel to the carburetor

1. Check the fuel shutoff solenoid
   a. Must have 12 volt while cranking the engine.
2. Check the electric fuel pump
   a. Must have 12 volts or be able to hear the pump running while cranking the engine.
   b. Check fuel pressure, must have a minimum of 2-4lbs.
3. Check Fuel Filter:

NOTE: *Some JLG machines have a fuel return line between the fuel pump and carburetor, if this return line is pinched and the fuel pressure increases this indicates a clogged fuel filter.*

4. Check the fuel pump supply line for any obstruction.

Try to start the engine.

NOTE: *JLG Industries Inc. recommends the use of engine block heaters and or cold weather packages for machines intended for use in 0° F (-18° C) or colder conditions. Refer to the JLG Parts Manual for specify options for your machine.*

(Machines equipped with non-hydrostatic gear pump or non-proportional drive systems, i.e. H models, 60HA should consider having block heaters and or cold weather packages installed for use in 20° F (-6.5° C) and colder conditions.

3.21 FORD EFI ENGINE (MACHINES AFTER S/N 58209)

Performing Diagnostics

1. Verify the complaint and determine if it is a deviation from normal operation.
2. Once the complaint has been verified, preliminary checks can be done. Conduct a thorough visual inspection, be alert for unusual sounds or odors, and gather diagnostic trouble code information.
3. Perform a system check that will verify the proper operation of the system in question and check for recent information updates.
4. If a diagnostic trouble code (DTC) is stored, contact a JLG distributor to make an effective repair.
5. If no DTC is stored, select the symptom from the symptom tables and follow the diagnostic path or suggestions to complete the repair.
6. After the repair has been made and validated for proper operation, the old part should be momentarily re-installed to verify that it was indeed the source of the problem.

If no matching symptom is available, analyze the complaint and develop a plan for diagnostics utilizing the wiring diagrams, technical assistance, and repair history.

Intermittent conditions may be resolved by using a check sheet to pinpoint the circuit or electrical system component. Some diagnostic charts contain Diagnostic Aids which give additional information about a system. Be sure to use all of the information that is available to you.

VISUAL/PHYSICAL ENGINE INSPECTION CHECK

Perform a careful visual and physical engine inspection before performing any diagnostic procedure. Perform all necessary repairs before proceeding with additional diagnosis, this can often lead to repairing a problem without performing unnecessary steps. Use the following guidelines when performing a visual/physical inspection check:

- Inspect engine for modifications or aftermarket equipment that can contribute to the symptom; verify that all electrical and mechanical loads or accessory equipment is "OFF" or disconnected before performing diagnosis.
- Inspect engine fluids for correct levels and evidence of leaks.
- Inspect vacuum hoses for damage, leaks, cracks, kinks and improper routing, inspect intake manifold sealing surface for a possible vacuum leak.
- Inspect PCV valve for proper installation and operation.
- Inspect all wires and harnesses for proper connections and routing; bent or broken connector pins; burned, chafed, or pinched wires; and corrosion. Verify that harness grounds are clean and tight.
- Inspect Engine Module, sensors, and actuators for physical damage.
- Inspect Engine Module grounds for cleanliness, tightness, and proper location.
- Inspect fuel system for adequate fuel level, and fuel quality (concerns such as proper octane, contamination, winter/summer blend).
- Inspect intake air system and air filter for restrictions.
- Inspect battery condition and starter current draw.

If no evidence of a problem is found after visual/physical engine check has been performed, proceed to MIL DTC retrieval procedure.

EFI Diagnostics (S/N 58209 to S/N 60188)

The EFI diagnostics are designed to assist in locating a faulty circuit or component. When a malfunction is detected by the Engine Control Module (ECM), a diagnostic trouble code (DTC) is set and the Malfunction Indicator Lamp (MIL) will be illuminated.

MIL DTC RETRIEVAL

Diagnostic trouble codes (DTCs) can be retrieved by pushing and holding the test button on the side of the ground control box. The Malfunction Indicator Light will illuminate for 2-3 seconds when the key is positioned to the on position to act as a self-test. If a DTC is present, the light will illuminate and stay on.

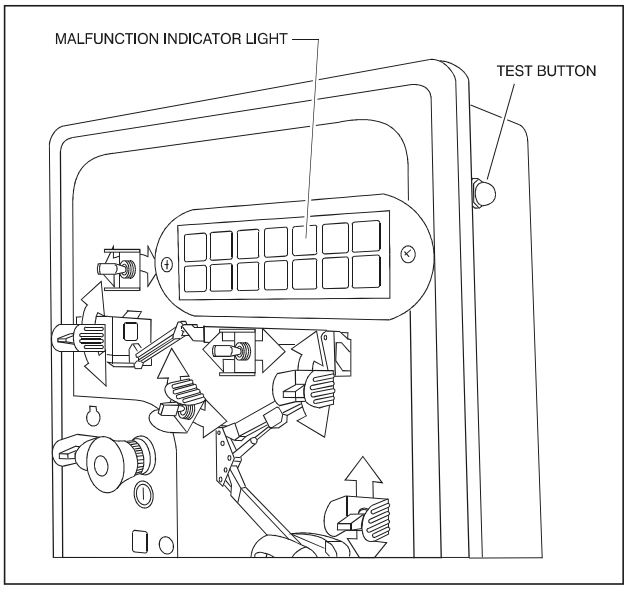


Figure 3-21. Malfunction Indicator Light and Test Button

When reading Diagnostic Trouble Codes thru the MIL, the following conditions apply:

- The flashing MIL is on for 0.4 second and off for 0.4 second.
- The MIL is off for 1.2 seconds between digits of two digit DTCs.
- The MIL is off for 2.4 seconds between DTCs.
- Each DTC repeats 3 times before the next stored DTC begins flashing.
- Up to 6 DTCs can be stored.
- Once all stored DTCs are flashed, the process repeats with the first stored DTC.
- DTCs are stored in the order in which they were set.

CLEARING TROUBLE CODES

To clear the trouble codes from the ECM, the electrical current running to the ECM must be shut off. To do this, disconnect the negative terminal from the battery for a period of approximately 15 minutes.

Engine Module and Sensors

CRANKSHAFT POSITION (CKP) SENSOR

The crankshaft position (CKP) sensor provides a signal used by the Engine Module to calculate the ignition sequence. The CKP sensor initiates the reference pulses which the Engine Module uses to calculate RPM and crankshaft position.

CAMSHAFT POSITION (CMP) SENSOR AND SIGNAL

The camshaft position (CMP) sensor sends a CMP signal to the Engine Module. The Engine Module uses this signal as a "sync pulse" to trigger the injectors in the proper sequence. The Engine Module uses the CMP signal to indicate the position of the #1 piston during its power stroke. The CMP uses a Hall Effect sensor to measure piston position. This allows the Engine Module to calculate true sequential fuel injection (SFI) mode of operation. If the Engine Module detects an incorrect CMP signal while the engine is running, DTC 53 will set. If the CMP signal is lost while the engine is running, the fuel injection system will shift to a calculated sequential fuel injection mode based on the last fuel injection pulse, and the engine will continue to nun. As long as the fault is present, the engine can be restarted. It will run in the previously established injection sequence.

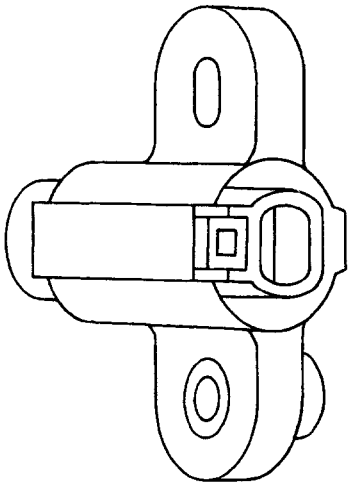


Table 3-2. ECM Diagnostic Trouble Codes

Diagnostic Trouble Code	Description
11	All Systems OK
12	Throttle Position (TP) Sensor Low Voltage
14	Manifold Absolute Pressure (MAP) Low Voltage
21	Overspeed
22	Throttle Position (TP) Sensor High Voltage
24	Manifold Absolute Pressure (MAP) High Voltage
31	Fuel Pump Low Voltage
32	Heated Oxygen Sensor (HO2S) Low Voltage
33	Engine Coolant Temperature (ECT) Sensor High Voltage
35	Intake Air Temperature (IAT) Sensor High Voltage
41	Fuel Pump High Voltage
42	Heated Oxygen Sensor (HO2S) High Voltage
43	Engine Coolant Temperature (ECT) Sensor Low Voltage
45	Intake Air Temperature (IAT) Sensor Low Voltage
51	Low Oil Pressure
52	Crankshaft Position (CKP) Sensor Extra/Missing Pulses
53	Camshaft Position Sensor (CMP) Sensor Illegal Pattern
54	Engine Control Module (ECM) Fault Illegal Operation
55	Engine Control Module (ECM) Fault Illegal Interruption
56	Engine Control Module (ECM) Fault COP (Computer Operating Properly) Failure
61	System Voltage Low
62	System Voltage High

Table 3-3. EPM Diagnostic Trouble Codes

Diagnostic Trouble Code	Description	Cause for Setting DTC
111	Closed Loop Multiplier High (LPG)	This fault sets if the Closed Loop multiplier exceeds the limits of normal operation and cannot correctly modify the fuel flow within its limits.
112	HO2S Open/Inactive (Bank 1)	This fault will set if HO2S 1 is cold, non-responsive, or inactive for 60 seconds or longer.
113	HO2S Open/Inactive (Bank 2)	This fault will set if HO2S 2 is cold, non-responsive, or inactive for 60 seconds or longer.
121	Closed Loop Multiplier High Bank 1 (Gasoline)	This fault sets if the Closed Loop multiplier exceeds the limits of normal operation. When the multiplier cannot correctly modify the fuel flow within its limits, the limit is enforced. NOTE: If this DTC is set in conjunction with DTC 132, the HO2S sensors may be cross connected.
122	Closed Loop Multiplier Low Bank 1 (Gasoline)	This fault sets if the Closed Loop multiplier exceeds the limits of normal operation. When the multiplier cannot correctly modify the fuel flow within its limits, it is limited at -35%. NOTE: If this DTC is set in conjunction with DTC 131, the HO2S sensors may be cross connected.
124	Closed Loop Multiplier Low (LPG)	This fault sets if the Closed Loop multiplier exceeds the limits of normal operation. When the multiplier cannot correctly modify the fuel flow within its limits, it is limited at -35%. When this condition occurs, the EPM perceives the engine to be running rich.
125	Closed Loop Multiplier High (Natural Gas)	This fault sets if the Closed Loop multiplier exceeds the limits of normal operation. When the multiplier cannot correctly modify the fuel flow within its limits, it is limited at 35%. When this fault occurs, it is because the EPM perceives the engine to be running lean.
126	Closed Loop Multiplier Low (Natural Gas)	This fault sets if the Closed Loop multiplier exceeds the limits of normal operation. When the multiplier cannot correctly modify the fuel flow within its limits, it is limited at -35%. This occurs when the module perceives the engine to be running rich.
131	Closed Loop Multiplier High Bank 2 (Gasoline)	This fault sets if the Closed Loop multiplier exceeds the limits of normal operation. When the multiplier cannot correctly modify the fuel flow within its limits, the limit is enforced.
132	Closed Loop Multiplier Low Bank 2 (Gasoline)	This fault sets if the Closed Loop multiplier exceeds the limits of normal operation. When the multiplier cannot correctly modify the fuel flow within its limits, it is limited at -35%.
141	Adaptive Lean Fault (High Limit- Gasoline)	This fault sets if the Adaptive multiplier exceeds the limits of normal operation.
142	Adaptive Rich Fault (Low Limit Gasoline)	This fault sets if the Adaptive multiplier exceeds the limits of normal operation.
143	Adaptive Learn High (LPG)	This fault will set if the adaptive multiplier exceeds the limits of normal operation.
144	Adaptive Learn Low (LPG)	This fault will set if the adaptive multiplier exceeds the limits of normal operation.

Table 3-3. EPM Diagnostic Trouble Codes

Diagnostic Trouble Code	Description	Cause for Setting DTC
145	Adaptive Learn High (Natural Gas)	This fault will set if the adaptive multiplier exceeds the limits of normal operation.
146	Adaptive Learn Low (Natural Gas)	This fault will set if the adaptive multiplier exceeds the limits of normal operation.
161	System Voltage Low	This fault will set if the EPM detects voltage less than 9.5 for 5 seconds or longer while the alternator should be charging. The adaptive learn is disabled due to the inability of the EPM to correctly time injector openings.
162	System Voltage High	This fault will set if the EPM detects voltage greater than 18 volts for 3 seconds at anytime the engine is cranking or running. The adaptive learn is disabled due to the inability of the EPM to correctly time the injector openings. The EPM will shut down with internal protection with more than 26 volts. A fuse will then blow in the harness.
211	IAT High Voltage	This fault will set if the signal voltage is more than 4.95 volts anytime the engine is running. The EPM will use the default value for the IAT sensor in the event of this fault.
212	IAT Low Voltage	This fault will set if the signal voltage is less than 0.05 volts anytime the engine is cranking or running. The EPM will use a default value for the IAT sensor in the event
213	IAT Higher Than Expected 1	This fault will set if the Intake Air Temperature is greater than 200 deg.F and engine RPM is greater than 1000 and Power Derate 1 will be enforced. During this fault, maximum throttle position is 50% and the MIL light will flash twice per second.
214	IAT Higher Than Expected 2	This fault will set if the Intake Air Temperature is greater than 210 deg.F and engine RPM is greater than 1000. The MIL light will be on during this active fault and the engine will shut down.
215	Oil Pressure Low	This fault can be configured two different ways. It may use a normally closed switch or a normally open switch. If the switch is normally open, the fault will set if the circuit becomes grounded. If the switch is normally closed, the fault will set if the circuit becomes open. Go to the Fault page on Diagnostic Tool to determine how the input is configured. (“Open is OK” is normally open and “Ground is OK” is normally closed). The engine will shut down in the event of this fault to help prevent possible damage.
221	ECT High Voltage	This fault will set if the signal voltage is greater than 4.95 volts anytime the engine is running. The EPM will use a default value for the ECT sensor in the event of this fault.
222	ECT Low Voltage	This fault will set if the signal voltage is less than 0.05 volts anytime the engine is running. The EPM will use a default value for the ECT sensor in the event of this fault.
231	MAP High Pressure	This fault will set when the MAP reading is higher than it should be for the given TPS, and RPM. When the fault is set, the Adaptive Learn will be disabled for the remainder of the key on cycle and the MIL will be on. The engine will operate on a default MAP during this active fault.

Table 3-3. EPM Diagnostic Trouble Codes

Diagnostic Trouble Code	Description	Cause for Setting DTC
232	MAP Low Voltage	This fault will set when the MAP reading is lower than the sensor should normally produce. When this fault is set the Adaptive learn will be disabled for the remainder of the key on cycle and the MIL will be on.
234	BP High Pressure	This fault sets in the event the BP value is out of the normal range.
235	BP Low Pressure	This fault sets in the event the BP value is out of the normal range.
242	Crank Sync Noise	The EPM must see a valid Crankshaft position signal while running. If no signal is present for 800ms or longer, this fault will set.
243	Never Crank Synced At Start	The EPM must see a valid Crankshaft Position signal while cranking before it starts. If no signal is present within 4 cranking revs, this fault will set.
244	Camshaft Sensor Loss	The Camshaft Position Sensor is used to determine which cylinder to fire. This fault will set if the EPM does not detect a cam pulse when the RPM is greater than 1000. Normally the engine will run with this fault present. In some instances this fault may cause rough engine operation.
245	Camshaft Sensor Noise	This fault will set if the EPM detects erroneous pulses from the camshaft position sensor causing invalid cam re-sync.
253	Knock Sensor Open	This fault will set if the Knock Sensor input to the EPM is less than 0.2 volt while engine rpm is greater than 1500 and MAP is greater than 8 psia.
254	Excessive Knock Signal	This fault will set if the Knock Sensor input to the EPM is greater than 4.5 volts while MAP is less than 8 psia and knock spark retard is at maximum.
311	Injector Driver #1 Open (2.5L)	This fault will set if the EPM detects low feedback voltage on the internal injector while the injector drive circuit is in the off-state and battery voltage is greater than 9 volts.
312	Injector Driver #1 Shorted (2.5L)	This fault will set if the EPM detects 10 injector firings with the internal driver sense voltage greater than 4 volts while the injector is in the on-state and battery voltage is less than 16 volts.
313	Injector Driver #2 Open (2.5L)	This fault will set if the EPM detects low feedback voltage on the internal injector while the injector drive circuit is in the off- state and battery voltage is greater than 9 volts.
314	Injector Driver #2 Shorted (2.5L)	This fault will set if the EPM detects 10 injector firings with the internal driver sense voltage greater than 4 volts while the injector is in the on-state and battery voltage is less than 16 volts.
315	Injector Driver #3 Open (2.5L)	This fault will set if the EPM detects low feedback voltage on the internal injector while the injector drive circuit is in the off-state and battery voltage is greater than 9 volts.
316	Injector Driver #3 Shorted (2.5L)	This fault will set if the EPM detects low feedback voltage on the internal injector while the injector drive circuit is in the off-state and battery voltage is greater than 9 volts.

Table 3-3. EPM Diagnostic Trouble Codes

Diagnostic Trouble Code	Description	Cause for Setting DTC
321	Injector Driver #4 Open (2.5L)	This fault will set if the EPM detects 10 injector firings with the internal driver sense voltage greater than 4 volts while the injector is in the on-state and battery voltage is less than 16 volts.
322	Injector Driver #4 Shorted (2.5L)	This fault will set if the EPM detects 10 injector firings with the internal driver sense voltage greater than 4 volts while the injector is in the on-state and battery voltage is less than 16 volts.
351	Fuel Pump Loop Open or High Side Short To Ground	This fault will set if the EPM detects Fuel Pump high-side on-state voltage less than 4 volts while battery voltage is greater than 8 volts. When this fault occurs, the MIL light will illuminate and the engine will shut down.
352	Fuel Pump High Side Shorted To Power	This fault will set if the EPM detects Fuel Pump high-side voltage greater than 4 volts while the pump should be off and the battery voltage is less than 16 volts. When this fault occurs, the MIL light will illuminate and the engine will shut down.
411	Coil Driver #1 Open (2.5L)	This fault will set if the EPM detects 10 coil firings which require the adaptive dwell to be greater than allowed with the battery voltage above 11 volts.The purpose of this fault is to detect an open or high impedance circuit to the coil, or an open primary coil.
412	Coil Driver #1 Shorted (2.5L)	This fault will set if the EPM detects 10 coil firings in which the adaptive dwell is less allowed and battery voltage is less than 16 volts.The purpose of this fault is to detect a short to ground in the harness, or internally to the primary coil.
413	Coil Driver #2 Open (2.5L)	This fault will set if the EPM detects 10 coil firings which require the adaptive dwell to be greater than allowed with the battery voltage above 11 volts. The purpose of this fault is to detect an open or high impedance circuit to the coil, or an open primary coil.
414	Coil Driver #2 Shorted (2.5L)	This fault will set if the EPM detects 10 coil firings in which the adaptive dwell is less than allowed and battery voltage is less than 16 volts. The purpose of this fault is to detect a short to ground in the harness, or internally to the primary coil.
511	FPP1 High Voltage	This fault will set if voltage is over 4.8 volts at any operating condition while the key is on. If the voltage exceeds 4.8, then FPP1 is considered to be out of specifications. At this point the EPM does not have a valid signal, and must therefore enforce the low rev limit and Power Derate (level 1). When these are enforced the maximum throttle position is 50% and the maximum engine speed is 1600 RPM. The Low Rev Limit is enforced for the remainder of the key-on cycle. Rev limit is still enforced if the active fault is no longer present; the MIL light will flash at 2 Hz for the remainder of the key-on cycle. This is a reminder that the Low Rev Limit is still enforced.
512	FPP1 Low Voltage	This fault will set if voltage is less than 0.2 volts at any operating condition while the key is on. If the voltage is less than 0.2, then FPP1 is considered to be out of specifications. At this point the EPM does not have a valid signal, and must therefore enforce the low rev limit and Power Derate (level-1). When these are enforced the maximum throttle position is 50% and the maximum engine speed is 1600 RPM. The low rev limit is enforced for the remainder of the key- on cycle. If the active fault is no longer present, the MIL light will flash at 2 Hz for the remainder of the key-on cycle. This is a reminder that the Low Rev Limit is still enforced.

Table 3-3. EPM Diagnostic Trouble Codes

Diagnostic Trouble Code	Description	Cause for Setting DTC
513	FPP1 Higher Than IVS Limit	This fault will set if the IVS is at idle (open) and the FPP 1 voltage is greater than 1.2 volts. During this fault, Power Derate (level 2) and the Low Rev Limit are enforced. When these are enforced the maximum throttle position is 20% and the maximum engine speed is 1600 RPM. The Low Rev Limit and Power Derate are enforced for the remainder of the key-on cycle. If the active fault is no longer present, the MIL light will flash at 2 Hz for the remainder of the key-on cycle. This is a reminder that the Power Derate and Low Rev Limits are still enforced.
514	FPP1 Lower Than IVS Limit	This fault will set if the IVS is off-idle (closed) and the FPP 1 voltage is less than 0.6 volts. During this fault, Power Derate (level 2) and the Low Rev Limit are enforced. When these are enforced the maximum throttle position is 20% and the maximum engine speed is 1600 RPM. These are enforced for the remainder of the key-on cycle. If the active fault is no longer present, the MIL light will flash at 2 Hz for the remainder of the key-on cycle. This is a reminder that the Power Derate and Low Rev Limits are still enforced.
521	FPP2 High Voltage	This fault will set if signal voltage is over 4.8 volts at any operating condition while the key is on.If the voltage exceeds 4.8, then FPP2 is considered out of specification. At this point the EPM does not have a valid signal, and must therefore enforce the Low Rev Limit and Power Derate (level 1). When these are enforced the maximum throttle position is 50% and the maximum engine speed is 1600 RPM. The Low Rev Limit is enforced for the remainder of the key-on cycle. If the active fault is no longer present, the MIL light will flash at 2 Hz for the remainder of the key-on cycle. This is a reminder that the Low Rev Limit is still enforced.
522	FPP2 Low Voltage	This fault will set if signal voltage is less than 0.2 volts at any operating condition while the key is on. If the voltage is less than 0.2, then FPP2 is considered out of specification. At this point the EPM does not have a valid signal, and must therefore enforce the low rev limit and Power Derate (level 1). When these are enforced the maximum throttle position is 50% and the maximum engine speed is 1600 RPM. The low rev limit is enforced for the remainder of the key-on cycle. If the active fault is no longer present, the MIL light will flash at 2 Hz for the remainder of the key-on cycle. This is a reminder that the Low Rev Limit is still enforced.
531	TPS1 (Signal Voltage) High	This fault will set if voltage is above 4.8 volts at any operating condition while the engine is cranking or running. The engine will not start or run during this active fault.
532	TPS1 (Signal Voltage) Low	This fault will set if voltage is less than 0.2 volts at any operating condition while the engine is cranking or running. The engine will not start or run during this active fault.
533	TPS2 (Signal Voltage) High	This fault will set if voltage is above 4.8 volts at any operating condition while the engine is cranking or running. The engine will not start or run during this active fault. Throttle Position Sensor #2
534	TPS2 (Signal Voltage) Low	This fault will set if voltage is below 0.2 volts at any operating condition while the engine is cranking or running. The engine will not start or run during this active fault.

Table 3-3. EPM Diagnostic Trouble Codes

Diagnostic Trouble Code	Description	Cause for Setting DTC
535	TPS1 Higher Than TPS2	This fault will set if TPS1 is 20% (or more) higher than TPS2. At this point the throttle is considered to be out of specification, or there is a problem with the TPS signal circuit. During this active fault, the MIL light will be on and the engine will shut down.
536	TPS1 Lower Than TPS2	This fault will set if TPS1 is 20% (or more) lower than TPS2. At this point the throttle is considered to be out of specification, or there is a problem with the TPS signal circuit. During this active fault, the MIL light will be on and the engine will shut down.
537	Throttle Unable To Open	This fault will set if the throttle command is 20% or more than the actual throttle position. During this active fault the MIL light will be on and the engine will shut down.
538	Throttle Unable To Close	This fault will set if the throttle command is 20% less than the actual throttle position. During this active fault the MIL light will be on and the engine will shut down.
545	Governor Interlock Failure	This fault will set if Gov. 1, 2, or 3 are enabled and the EPM does not detect a ground from the brake switch input. During this active fault the MIL light will be on and Power Derate (level 1) and the Low Rev Limit will be enforced. When these are enforced the maximum throttle position is 50% and the maximum engine speed is 1600 RPM. The Low Rev Limit is enforced for the remainder of the key-on cycle. If the active fault is no longer present, the MIL light will flash at 2 Hz for the remainder of the key-on cycle. This is a reminder that the Low Rev Limit is still enforced.
551	Max Govern Speed Override	This fault will set anytime the engine RPM exceeds 4500 for 2 seconds or more continuously. This speed overrides any higher max governor speeds programmed by the user. This is to help prevent engine or equipment damage.
552	Fuel Rev Limit	This fault will set anytime engine RPM exceeds 4800 for 2 seconds or more continuously. When these conditions are met, the EPM shuts off the fuel injectors. This is to help prevent engine or equipment damage. NOTE: If any other DTCs are present, diagnose those first.
553	Spark Rev Limit	This fault will set anytime the engine RPM exceeds 4900 for 2 seconds or more continuously. When these conditions are met, the EPM will shut off spark to the engine. This is to help prevent engine or equipment damage. NOTE: If any other DTCs are present, diagnose those first.
611	COP Failure	Several different things can happen within the microprocessor that will cause this fault. The EPM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

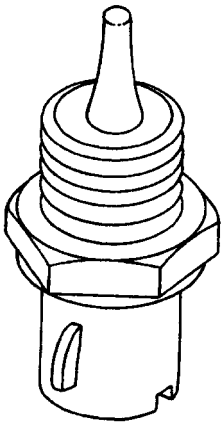
Table 3-3. EPM Diagnostic Trouble Codes

Diagnostic Trouble Code	Description	Cause for Setting DTC
612	Invalid Interrupt	Several different things can happen within the microprocessor that will cause this fault. The EPM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.
613	A/D Loss	This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.
614	RTI 1 Loss	Several different things can happen within the microprocessor that will cause this fault. The EPM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.
615	Flash Checksum Invalid	Several different things can happen within the microprocessor that will cause this fault. The EPM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.
616	RAM failure	This fault will set if the EPM detects a problem accessing or writing information to RAM. This fault will not self erase and must be cleared manually.
631	External 5V Ref Lower Than Expected	This fault will set if the 5 Volt reference is below 4.6 volts.
632	External 5V Ref Higher Than Expected	This fault will set if the 5 Volt reference is above 5.4 volts.
655	RTI 2 Loss	Several different things can happen within the microprocessor that will cause this fault. The EPM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.
656	RTI 3 loss	Several different things can happen within the microprocessor that will cause this fault. The EPM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The engine coolant temperature (ECT) sensor is a g thermistor (a resistor which changes value based on temperature) mounted in the engine coolant stream. Low coolant temperature produces a high resistance of 100,000 ohms at -40°C (-40°F). High temperature causes a low resistance of 70 ohms at 130°C (266°F). The Engine Module supplies a 5-volt signal to the ECT sensor through resistors in the Engine Module and measures the voltage. The signal voltage will be high when the engine is cold and low when the engine is hot. By measuring the voltage, the Engine Module calculates the engine coolant temperature. Engine coolant temperature affects most of the systems that the Engine Module controls.

After engine start-up, the temperature should rise steadily to about 85°C (185°F). it then stabilizes when the thermostat opens. If the engine has not been run for several hours (overnight), the engine coolant temperature and intake air temperature displays should be close to each other. A fault in the engine coolant sensor circuit will set DTC 33 or DTC 43.



ELECTRICALLY ERASABLE PROGRAMMABLE READ ONLY MEMORY (EEPROM)

The electrically erasable programmable read only memory (EEPROM) is a permanent memory chip that is located within the Engine Module. The EEPROM contains the pro-gram and the calibration information that the Engine Module needs to control engine operations.
If the Engine Module is replaced, the new Engine Module will need to be programmed. An IBM-compatible computer and software containing the correct program and calibration for the application are required to program the Engine Module.

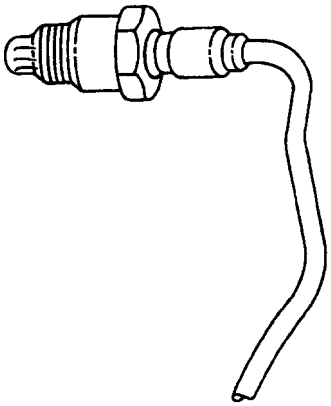
HEATED OXYGEN SENSOR

The heated oxygen sensor is mounted in the exhaust stream where it can monitor the oxygen content of the exhaust gas. The oxygen present in the exhaust gas reacts with the sensor to produce a voltage output. This voltage should constantly fluctuate from approximately 100 mV to 900 mV. The heated oxygen sensor voltage can be monitored on an IBM PC-compatible computer with diagnostic software. By monitoring the voltage out-put of the oxygen sensor, the Engine Module calculates the pulse width command for the injectors to produce the proper combustion chamber mixture.

Low HO2S voltage indicates a lean mixture which will result in a rich command to compensate.

High HO2S voltage indicates a rich mixture which will result in a lean command to compensate.

A constant voltage below 200 mV for 10 consecutive seconds will set OTC 32. A constant voltage above 650 mV for 10 consecutive seconds will set OTC 42.



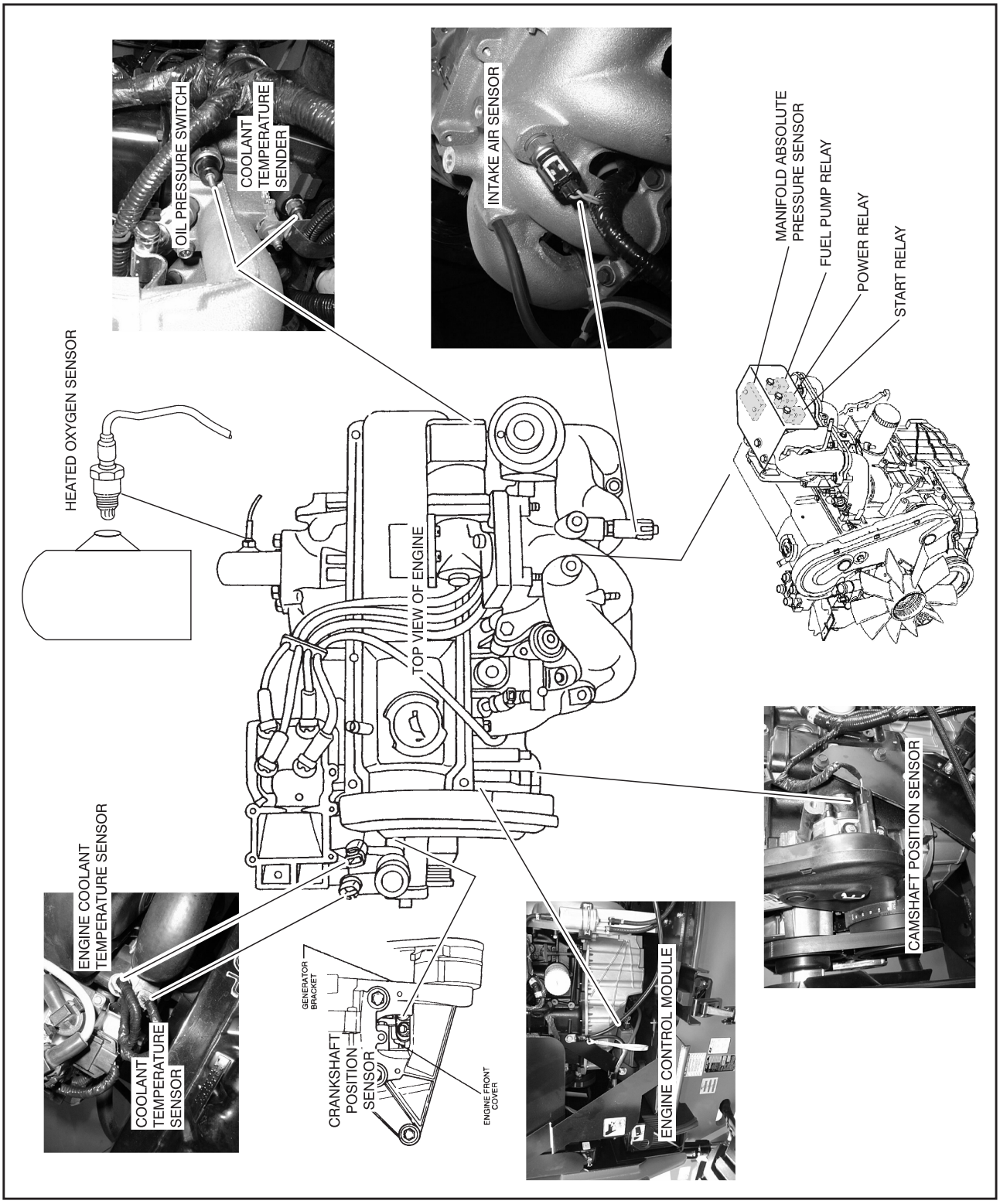
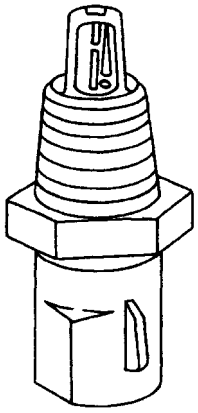


Figure 3-22. EFI Component Location

INTAKE AIR TEMPERATURE (IAT) SENSOR

The intake air temperature (IAT) sensor is a thermistor which changes its resistance based on the temperature of air entering the engine. Low temperature produces a high resistance of 100,000 ohms at -40°C (-40°F). High temperature causes a low resistance of 70 ohms at 130°C (266°F). The Engine Module supplies a 5-volt signal to the sensor through a resistor in the Engine Module and monitors the signal voltage. The signal voltage will be high when the incoming air is cold and low when the incoming air is hot. By measuring the voltage, the Engine Module calculates the incoming air temperature. The IAT sensor signal is used to adjust spark timing according to the incoming air density. An IBM PC-compatible computer with diagnostic soft-ware can be used to display the temperature of the air entering the engine. The temperature should read close to the ambient air temperature when the engine is cold, and rise as engine compartment temperature increases. If the engine has not been run for several hours (overnight), the IAT sensor temperature and engine coolant temperature should read close to each other. A failure in the IAT sensor circuit will set DTC 35 or DTC 45.



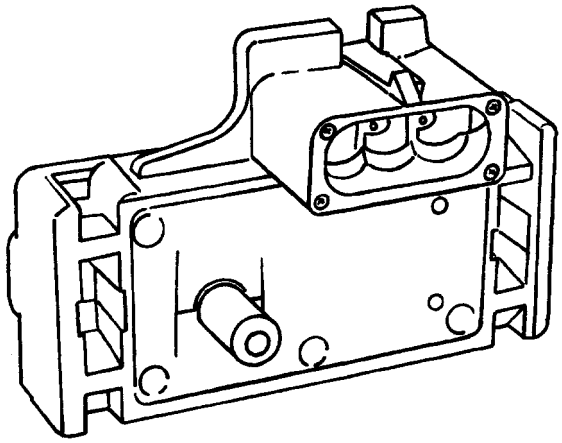
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The manifold absolute pressure (MAP) sensor responds to changes in intake manifold pressure (vacuum). The MAP sensor signal voltage to the Engine Module varies from below 2 volts at idle (high vacuum) to above 4 volts with the ignition ON, engine not running or at wide-open throttle (low vacuum).

The MAP sensor is used to determine the following:

- Engine vacuum level for engine control purposes.
- Barometric pressure (BARO)

If the Engine Module detects a voltage that is significantly lower than the estimated MAP value for 2 or more consecutive seconds, DTC 14 will be set. A signal voltage significantly higher than the estimated MAP value for 2 or more consecutive seconds will set DTC 24.



ENGINE CONTROL MODULE (ECM)/ENGINE PERFORMANCE MODULE (EPM)

The engine will be controlled by one of two different Engine Modules. The Ford EFI engine was originally equipped with an ECM. The EPM was developed to replace the ECM and provide enhanced performance and durability. To see the physical difference between the ECM and EPM, refer to Figure 3-23., ECM/EPM Identification.

The Engine Module controls the following:

- Fuel metering system
- Ignition timing
- On-board diagnostics for engine functions

The Engine Module constantly observes the information from various sensors. The Engine Module controls the systems that affect engine performance. The Engine Module performs the diagnostic function of the system. It can recognize operational problems, alert the operator through the Malfunction Indicator Lamp (MIL), and store diagnostic trouble codes (DTCs). DTCs identify the problem areas to aid the technician in making repairs.

The Engine Module supplies either 5 or 12 volts to power various sensors or switches. The power is supplied through resistances in the Engine Module which are so low in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, a digital voltmeter with at least 10 meg ohms input impedance is required to ensure accurate voltage readings. The Engine Module controls output circuits such as the fuel injectors, electronic governor, etc., by control ling the ground or the power feed circuit through transistors or other solid state devices.

The Engine Module is designed to maintain exhaust emission levels to government mandated standards while providing excellent operation and fuel efficiency. The Engine Module monitors numerous engine functions via electronic sensors such as the throttle position (TP) sensor and the heated oxygen sensor (HO2S).

ENGINE MODULE INPUTS/OUTPUTS

Inputs—Operating Conditions

- Engine Coolant Temperature
- Crankshaft Position
- Exhaust Oxygen Content
- Manifold Absolute Pressure
- Battery Voltage
- Throttle Position
- Fuel Pump Voltage
- Intake Air Temperature
- Camshaft Position

Outputs - System Controlled

- Fuel Control
- Idle Air Control
- Electric Fuel Pump
- Diagnostics:
  - Malfunction Indicator Lamp
  - Data Link Connector (DLC)

ENGINE MODULE SERVICE PRECAUTIONS

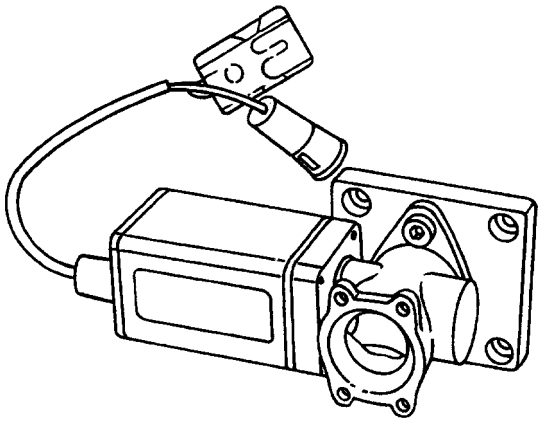
The Engine Module is designed to withstand normal current draws associated with engine operation. When servicing the Engine Module, observe the following guidelines:

- Do not overload any circuit.
- Do not probe wires for testing. This can cause a voltage drop that would be critical to the operation of the Engine Module.
- When testing for opens and shorts, do not ground or apply voltage to any of the Engine Module's circuits unless instructed to do so.
- When measuring voltages, use only a digital voltmeter with an input impedance of at least 10 megohms.
- Do not jump start with more than 12 volts. This could cause damage to the electronic components.
- Do not employ any non-standard practices such as charging the battery with an arc welder.
- Take proper precautions to avoid static damage to the Engine Module. Refer to "Electrostatic Discharge Damage" for more information.

THROTTLE POSITION (TP) SENSOR

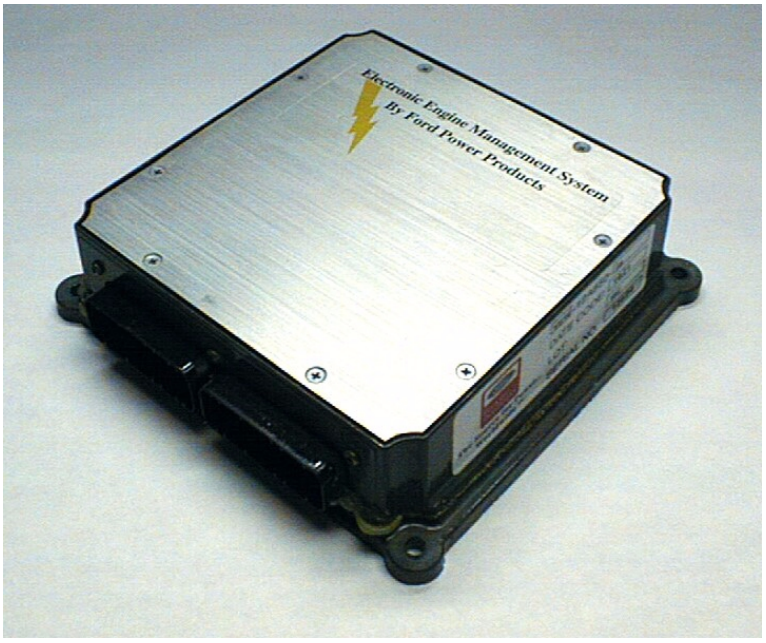
The throttle position (TP) sensor is a potentiometer connected to the throttle shaft on the throttle body which is built into the electronic governor. The Engine Module monitors the voltage on the signal line and calculates throttle position. As the throttle valve angle is changed, the TP sensor signal also changes. At a closed throttle position, the output of the TP sensor is low. As the throttle valve opens, the output increases so that at wide open throttle (WOT), the output voltage should be above 4 volts.

The Engine Module calculates fuel delivery based on throttle valve angle (operator demand). A broken or loose TP sensor may cause intermittent bursts of fuel from an injector and unstable idle because the Engine Module thinks the throttle is moving. A hard failure in the TP sensor 5-Volt reference or signal circuits for greater than 2 consecutive seconds will set either a DTC 12 or DTC 22. A hard failure with the TP sensor ground circuit for more than two consecutive seconds may set DTC 22. If either DTC 12 or DTC 22 are set, the throttle will be forced to a 6% (idle) position.

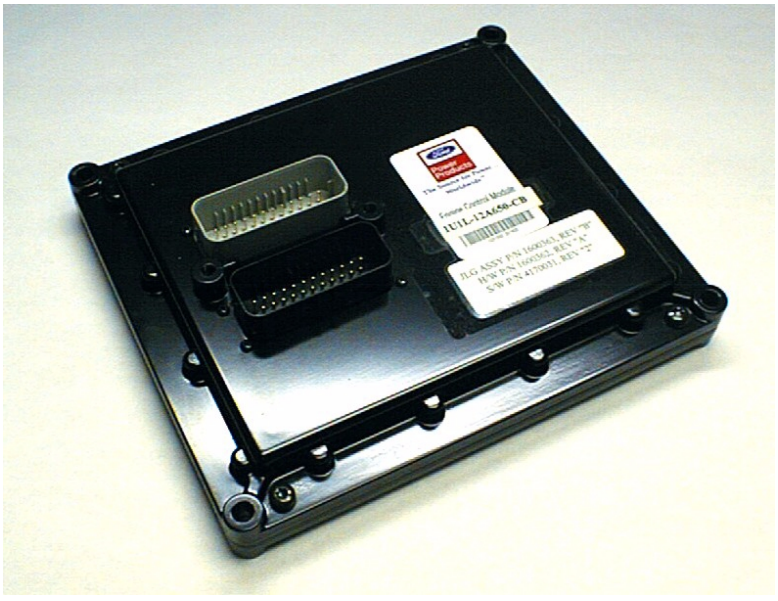


USE OF CIRCUIT TESTING TOOLS

Do not use a test light to diagnose the engine electrical systems unless specifically instructed by the diagnostic procedures. A test light can put an excessive load on an Engine Module circuit and result in component damage. For volt-age measurements, use only a digital voltmeter with an input impedance of at least 10 megohms.



ECM



EPM

Figure 3-23. ECM/EPM Identification

ELECTROSTATIC DISCHARGE DAMAGE

Electronic components used in the Engine Module are often designed to carry very low voltage. Electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 volts of static electricity can cause damage to some electronic components. By comparison, It takes as much as 4000 volts for a person to feel the spark of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and induction.

An example of charging by friction is a person sliding across a seat.

Charge by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges can cause damage, therefore it is important to-use care when handling and testing electronic components.

To prevent possible electrostatic discharge damage, follow these guidelines:

- Do not touch the Engine Module connector pins or soldered components on the Engine Module board.
- Do not open the replacement part package until the part is ready to be installed.
- Before removing the part from the package, ground the package to a known good ground on the equipment.
- If the part has been handled while sliding across a seat, while sitting down from a standing position, or while walking a distance, touch a known good ground before installing the part.

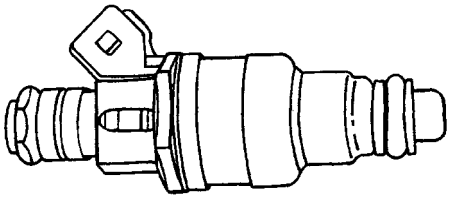
Fuel System

FUEL INJECTOR

The Electronic Fuel Injection (EFI) fuel injector is a solenoid-operated device controlled by the Engine Module. The Engine Module energizes the solenoid, which opens a valve to allow fuel delivery.

The fuel is injected under pressure in a conical spray pattern at the opening of the intake valve. Excess fuel not used by the injectors passes through the fuel pressure regulator before being returned to the fuel tank.

A fuel injector which is stuck partly open will cause a loss of fuel pressure after the engine is shut down, causing long crank times.



FUEL METERING SYSTEM COMPONENTS

The fuel metering system is made up of the following parts:

- The fuel injectors
- The fuel rail
- The fuel pressure regulator/filter assembly
- The electronic governor
- The Engine Module
- The crankshaft position (CKP) sensor
- The camshaft position (CMP) sensor
- The fuel pump
- The fuel pump relay

BASIC SYSTEM OPERATION

The fuel metering system starts with the fuel in the fuel tank. The fuel is drawn up to the fuel pump through a prefilter. The electric fuel pump then delivers the fuel to the fuel rail through an inane fuel filter. The pump is designed to provide fuel at a pressure above the pressure needed by the injectors. A fuel pressure regulator in the fuel filter assembly keeps fuel available to the fuel injectors at a constant pressure. A return line delivers unused fuel back to the tank.

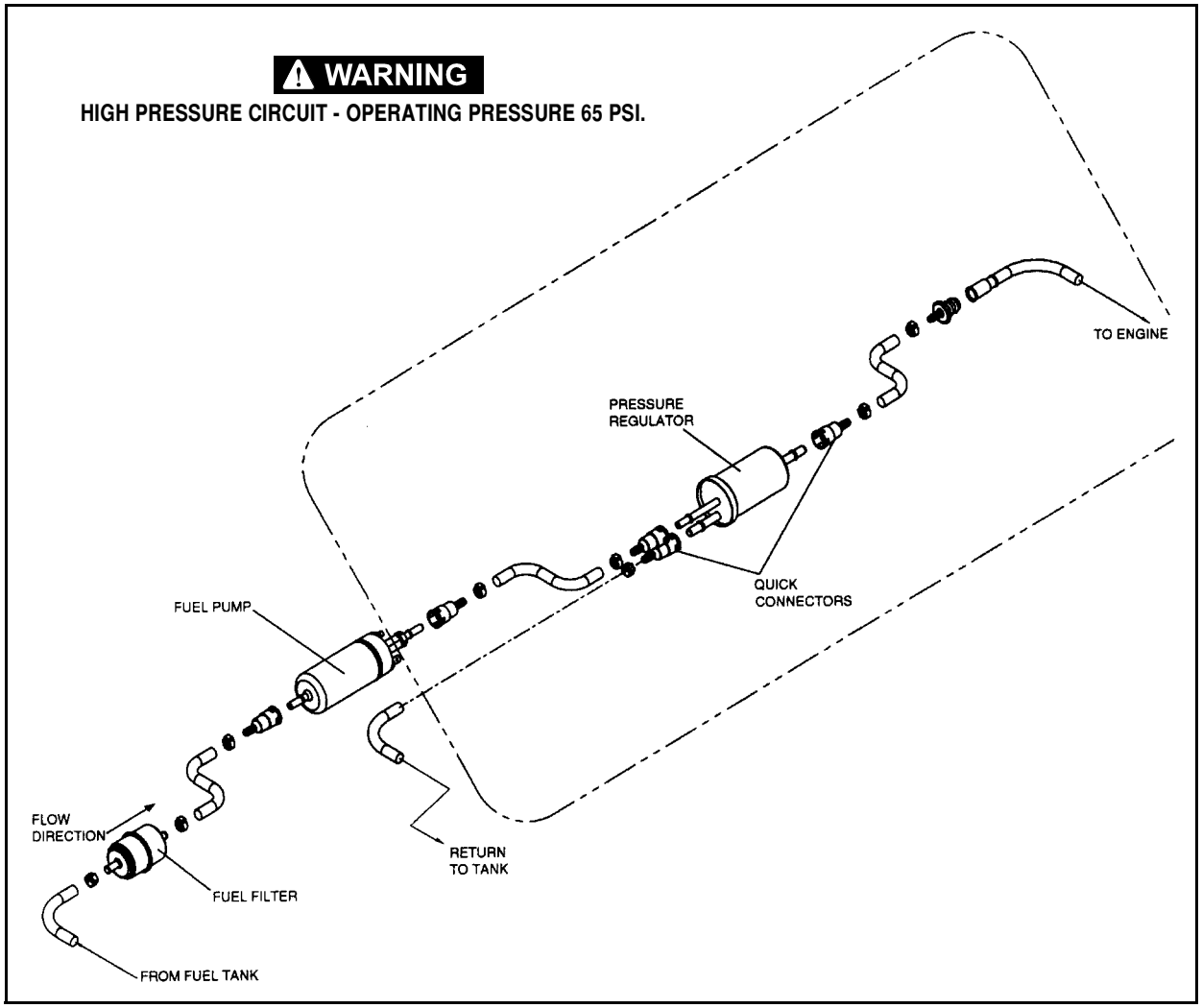


Figure 3-24. Typical Fuel System

FUEL METERING SYSTEM PURPOSE

The basic function of the air/fuel metering system is to control the air/fuel delivery to the engine. Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each intake valve.

The main control sensor is the heated oxygen sensor (H02S) located in the exhaust system. The H02S tells the Engine Module how much oxygen is in the exhaust gas. The Engine Module changes the air/fuel ratio to the engine by control-ling the amount of time that the fuel injector is "ON." The best mixture to minimize exhaust emissions is 14.7 parts of air to 1 part of gasoline by weight, which provides the most efficient combustion. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "closed loop" system.

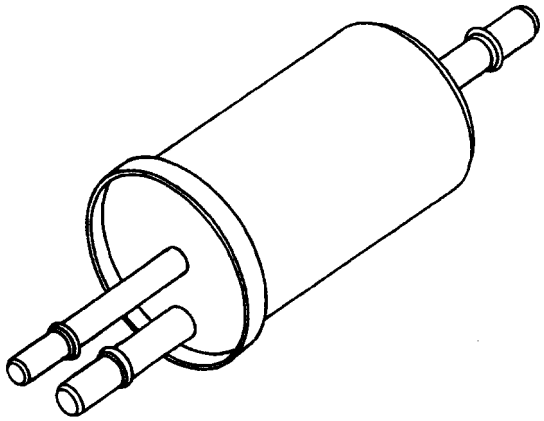
The Engine Module monitors signals from several sensors in order to determine the fuel needs of the engine. Fuel is delivered under one of several conditions called "modes." All modes are controlled by the Engine Module. Refer to "Open Loop and Closed Loop Operation" for more information.

FUEL PRESSURE REGULATOR

The fuel pressure regulator is a relief valve mounted in the fuel filter. It provides a constant fuel pressure of 441 kPa (64 psi).

If the pressure is too low, poor performance and a DTC 32 will set. If the pressure is too high, excessive odor and/or a DTC 42 will result.

When replacing the fuel filter, be sure to use an identical filter/regulator assembly. A standard fuel filter does not regulate pressure and could cause engine problems or component damage.



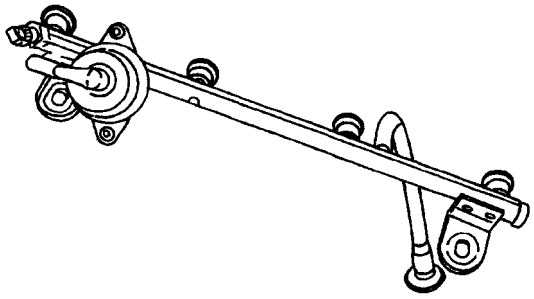
FUEL PUMP ELECTRICAL CIRCUIT

When the key is first turned "ON," the Engine Module energizes the fuel pump relay for two seconds to build up the fuel pressure quickly. If the engine is not started within two seconds, the Engine Module shuts the fuel pump off and waits until the engine is cranked. When the engine is cranked and crankshaft position signal has been detected by the Engine Module, the Engine Module supplies 12 volts to the fuel pump relay to energize the electric fuel pump.

An inoperative fuel pump will cause a "no-start" condition. A fuel pump which does not provide enough pressure will result in poor performance.

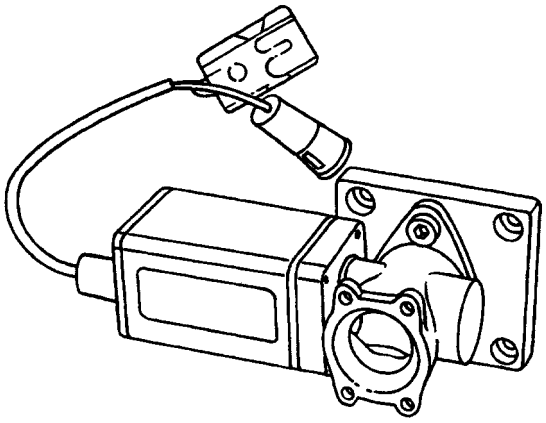
FUEL RAIL

The fuel rail is mounted to the top of the engine and distributes fuel to the individual injectors. Fuel is delivered to the fuel inlet tube of the fuel rail by the fuel lines.



ELECTRONIC GOVERNOR AND THROTTLE BODY

In the 2.5L EFI industrial engine, throttle control is achieved by using an electronic governor which is controlled by the Engine Module.



The electronic governor consists of a throttle body, an electronically-actuated throttle plate, and a built-in throttle position (TP) sensor. There are two pigtails that exit the governor body. The 3-wire pigtail connects the TP sensor to the Engine Module. Refer to "Throttle Position (TP) Sensor" for more information.

The 2-wire pigtail carries the throttle signal from the Engine Module to the governor. Desired engine speeds are stored in the configuration program for each specific application, and can be changed with the Engine Module calibration software. When an engine speed is selected with the toggle switch, the Engine Module sends the appropriate signal to the governor. This is a pulse-width modulated (PWM) signal which cannot be read with conventional diagnostic tools such as a voltmeter. A 12-volt signal is pulsed on and off at a high rate of speed. The width of the "on" pulse determines the amount of throttle opening. The Engine Module sends a signal with the appropriate pulse width to the governor based on the operator's choice of switch settings.

The electronic governor also acts as an idle air control (IAC) valve. Changes in engine load are detected by the Engine Module by comparing manifold absolute pressure (MAP) with throttle position. When the Engine Module detects a change in engine load, it can adjust idle speed by changing the PWM signal to the governor.

OPEN LOOP AND CLOSED LOOP OPERATION

The Engine Module will operate in the following two modes:

- Open loop
- Closed loop

When the engine is first started, the system is in "open loop" operation. In open loop, the Engine Module ignores the signal from the heated oxygen sensor (HO2S). it uses a pre-programmed routine to calculate the air/fuel ratio based on inputs from the TP, ECT, and MAP sensors.

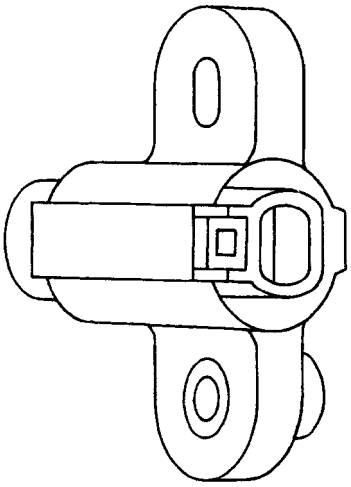
The system remains in open loop until the following conditions are met:

- The HO2S has a varying voltage output showing that it is hot enough to operate properly (this depends on temperature).
- The ECT has reached 160°F (71°C).
- Seven minutes has elapsed since starting the engine.

After these conditions are met, the engine is said to be operating in "closed loop." In closed loop, The Engine Module continuously adjusts the air/fuel ratio by responding to signals from the HO2S (except at wide-open throttle). When the HO2S reports a lean condition (low sensor signal voltage), the Engine Module responds by increasing the "on" time of the fuel injectors, thus enriching the mixture. When the HO2S reports a rich condition (high sensor signal Voltages the Engine Module responds by reducing the "on" time of the fuel injectors, thus leaning out the mixture.

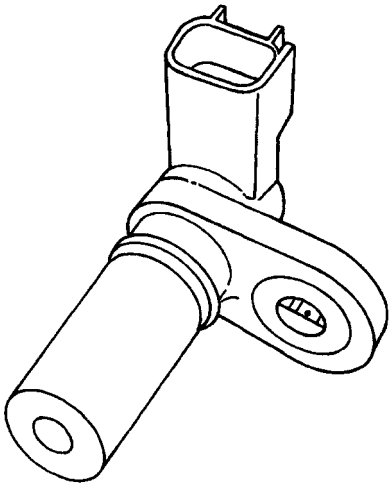
CAMSHAFT POSITION (CMP) SENSOR

The CMP sensor uses a variable reactor sensor to detect camshaft position. The CMP signal is created as piston #1 is a predetermined number of degrees after top dead center on the power stroke.



CRANKSHAFT POSITION (CKP) SENSOR

The crankshaft position (CKP) sensor provides a signal used by the engine control module (Engine Module) to calculate the ignition sequence. The sensor initiates the reference pulses which the Engine Module uses to calculate RPM and crank-shaft position.



ELECTRONIC IGNITION

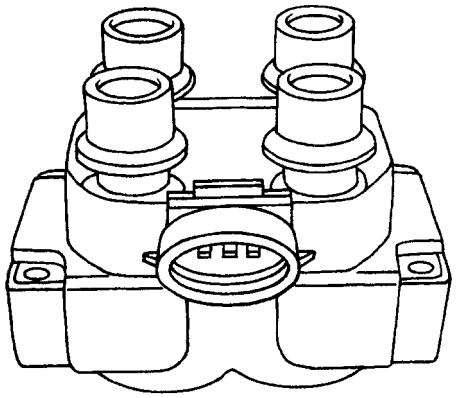
The electronic ignition system controls fuel combustion by providing a spark to ignite the compressed air/fuel w mixture at the correct time. To provide optimum engine performance, fuel economy, and control of exhaust emissions, the Engine Module controls the spark advance of the ignition system. Electronic ignition has the following advantages over a mechanical distributor system:

- No moving parts
- Less maintenance
- Remote mounting capability
- No mechanical load on the engine
- More coil cooldown time between firing events
- Elimination of mechanical timing adjustments
- Increased available ignition coil saturation time

IGNITION COIL

The electronic ignition system uses a coil pack with one ignition coil for each two cylinders in the engine. Each cylinder is paired with its opposing cylinder in the firing order, so that one cylinder on compression fires simultaneously with the opposing cylinder on exhaust. The spark that occurs in the cylinder on the exhaust stroke is referred to as a "waste spark."

The primary coils in the coil pack are triggered by the "Ignition Coil Feed #1" and "Ignition Coil Feed #2" Signals from the Engine Module.



ENGINE MODULE (ECM OR EPM)

The Engine Module is responsible for maintaining proper spark and fuel injection timing for all operating conditions. To provide optimum operation and emissions, the Engine Module monitors the input signals from the following components in order to calculate spark timing:

- Engine coolant temperature (ECT) sensor
- Intake air temperature (IAT) sensor
- Throttle position sensor
- Crankshaft position sensor

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SECTION 4. BOOM & PLATFORM

4.1 BOOM MAINTENANCE

Removal

1. Remove the platform/support as follows:
   a. Disconnect electrical cable from control console.
   b. Remove the eight (8) bolts securing the platform to the platform support, then remove the platform.
   c. Using an overhead crane or suitable lifting device, strap support the platform support.
   d. Remove the six (6) bolts and locknuts securing the support to the rotator.
   e. Using a suitable brass drift and hammer, remove the rotator shaft, then remove the support from the rotator.

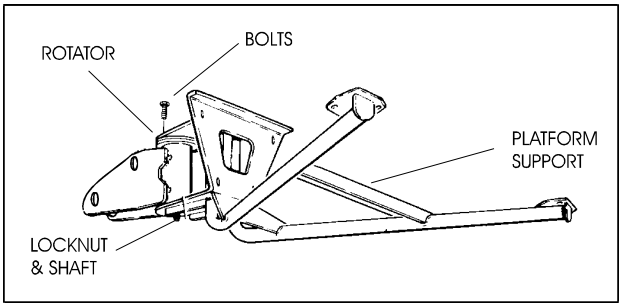


Figure 4-1. Location of Components - Platform Support

2. Remove the rotator and slave level cylinder from the fly boom as follows:
   a. Tag and disconnect hydraulic lines to rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
   b. Remove hardware from pin #1. Using a suitable brass drift and hammer remove pin #1 from the fly boom.
   c. Supporting the rotator, remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 from the fly boom and remove the rotator.
   d. Telescope the fly section out approximately 20 inches (50.8 cm) to gain access to the slave leveling cylinder.
   e. Supporting the slave, cylinder remove the hardware from pin #3. Using a suitable brass drift and hammer remove pin #3 from the fly boom.
   f. Tag and disconnect hydraulic lines to the slave leveling cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports. Remove the slave cylinder.

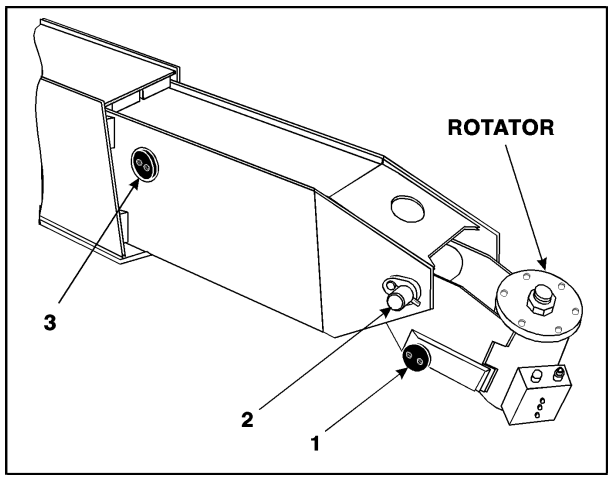


Figure 4-2. Location of Components - Rotator and Leveling Cylinder

3. Remove the powertrack from the boom as follows:
   a. Disconnect wiring harness from ground control box.

⚠ CAUTION

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

   b. Tag and disconnect hydraulic lines from boom to control valve. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
   c. Disconnect the dual capacity indicator limit switch from side of boom section.
   d. Remove hydraulic lines and electrical cables from powertrack.
   e. Using a suitable lifting equipment, adequately support powertrack weight along entire length.
   f. Remove bolts #1 securing the push tube on the fly boom section.
   g. Remove bolts #2 securing the push tube on the mid boom section.

h. With powertrack support and using all applicable safety precautions, remove bolts #3 and #4 securing rail to the base boom section. Remove powertrack from boom section.

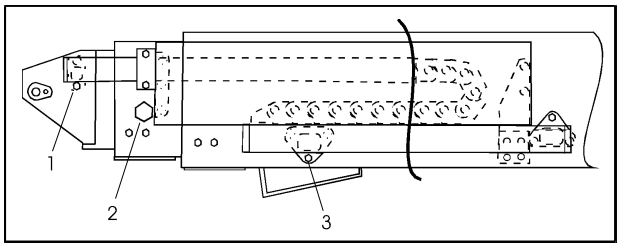


Figure 4-3. Location of Components - Boom Powertrack

4. Remove boom assembly from machine as follows:

   a. Using suitable lifting equipment, adequately support boom assembly weight along entire length.

⚠ CAUTION

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

   b. Tag and disconnect hydraulic lines from telescope cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.

   c. Remove hardware securing the lift cylinder rod end to the base boom section.

   d. Using a suitable brass drift and hammer, remove the lift cylinder pin from the base boom.

   e. Remove hardware securing the master cylinder rod end to the base boom section.

   f. Using a suitable brass drift and hammer, remove the master cylinder pin from the base boom.

   g. Remove hardware securing the pushbar to the turntable upright.

⚠ CAUTION

WHEN REMOVING PIN FROM PUSHBAR. CARE MUST BE TAKEN NOT TO DROP THE PUSHBAR ONTO THE WIRE ROPE ADJUSTMENT THREADS. FAILURE TO DO SO WILL RESULT IN DAMAGING THREADS.

   h. Using a suitable brass drift and hammer, remove the push bar pin from the turntable upright.

   i. Remove hardware securing the boom pivot pin to the turntable upright.

   j. Using a suitable brass drift and hammer, remove the pivot pin from the turntable upright.

   k. Using all applicable safety precautions, carefully lift boom assembly clear of turntable and lower to ground or suitably supported work surface.

Disassembly Boom Sections

1. Remove hardware securing the push bar to aft end of the telescope cylinder, then remove pin from cylinder.

2. Remove hardware securing the cover plate on the bottom front of the base boom section.

NOTE: *Do not allow wire rope to rotate. This may damage the wire rope.*

3. Clamp both threaded ends of wire rope to prevent rotation. Note: Do not clamp on threads. Remove jam nuts and nuts which secure the wire rope adjustments to the bottom front of the base boom section.

4. Remove hardware securing the wire rope adjustment block to aft end of the base boom section and remove the block.

5. Remove hardware securing the telescope cylinder to aft end of the mid boom section.

⚠ CAUTION

WHEN REMOVING THE TELESCOPE CYLINDER FROM THE BOOM, IT MAY BE NECESSARY AT SOME POINT IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY FROM THE BOOM. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

6. Remove bolts securing wire rope attach bar to top of fly boom section.
7. Pull the telescope cylinder and wire ropes partially from aft end of the base boom section; secure the cylinder with a suitable sling and lifting device at approximately the center of gravity.
8. Carefully remove the telescope cylinder and sheave assembly. Place telescope cylinder on a suitable trestle.
   a. Remove hardware from the wear pads; remove wear pads from cylinder.
   b. Remove hardware from the wire rope guard; remove guard from cylinder.
   c. Remove hardware from the sheave pin; remove pin and sheave from cylinder.

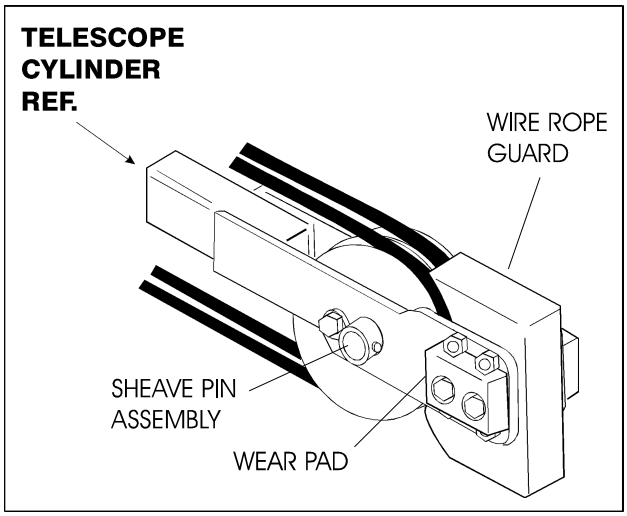


Figure 4-4. Disassembly of Sheave Assembly

9. Remove hardware which secures the wear pads to the front of base boom section; remove wear pads from the top, sides and bottom of the base boom section.
10. Using an overhead crane or suitable lifting device, remove mid and fly boom sections from base section. Note: When removing mid and fly boom sections from base boom section, retract wire rope must be dragged along with boom sections.
11. Remove hardware which secures the wear pads to the aft end of mid boom section; remove the wear pads from the top, sides and bottom of the mid boom section.

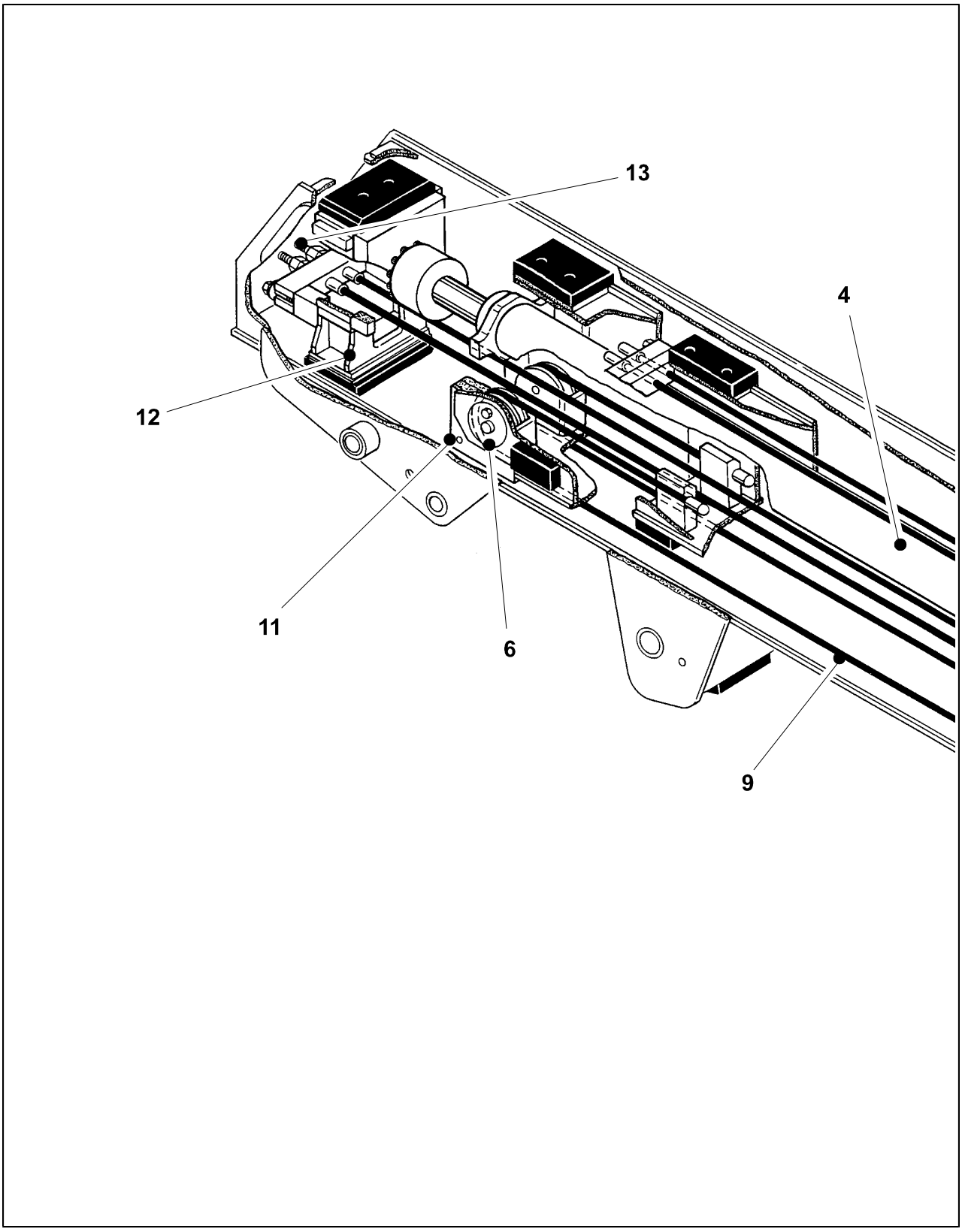


Figure 4-5. Boom Assembly Cutaway - Sheet 1 of 2

1. Base Boom
2. Mid Boom
3. Fly Boom
4. Telescope Cylinder
5. Extend Sheave
6. Retract Sheave
7. Sheave Block
8. Extend Cable
9. Retract Cable
10. Extend Sheave Guard
11. Retract Sheave Guard
12. Wear Pad Support
13. Extend Cable Adjustment
14. Retract Cable Adjustment

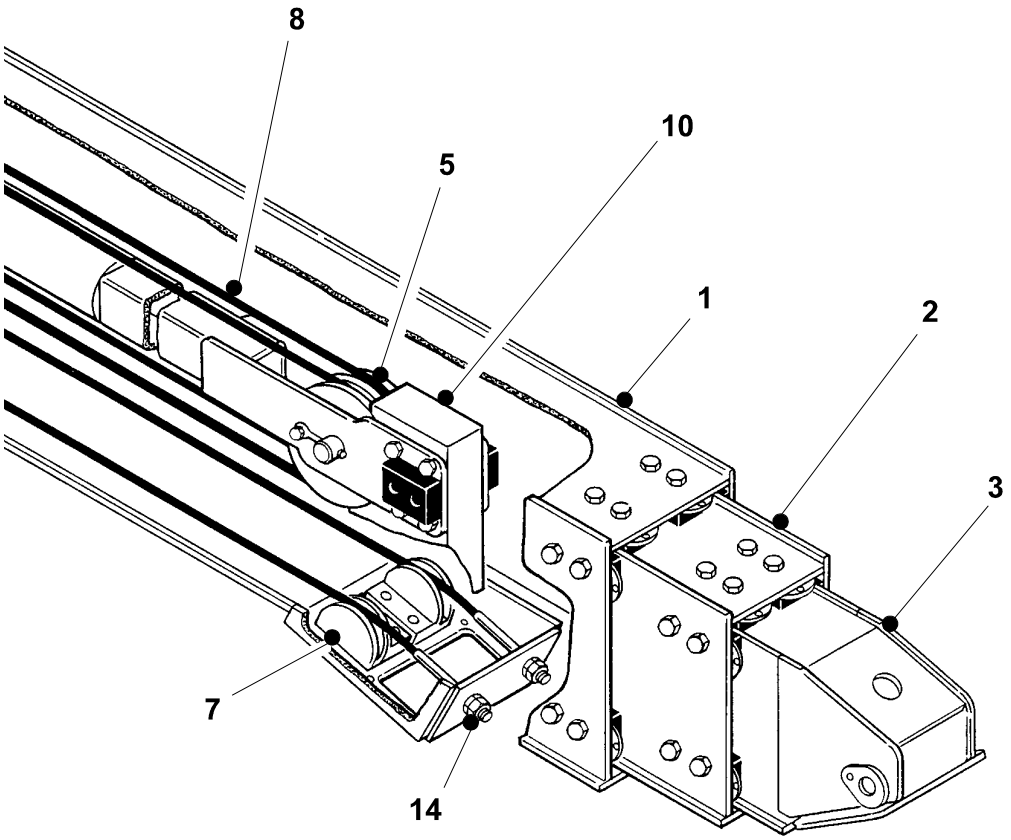


Figure 4-6. Boom Assembly Cutaway - Sheet 2 of 2

12. Remove hardware which secures the sheave guards and sheave assemblies to mid boom section, remove sheave assemblies from mid boom section.

13. Remove hardware which secures the wear pads to the front of mid boom section; remove wear pads from the top, sides and bottom of the mid boom section.

14. Using an overhead crane or suitable lifting device, remove fly boom section from mid section. Note: When removing fly boom section from mid boom section, retract wire rope must be dragged along with fly boom section.

15. Remove hardware which secures the wear pads to the aft end of fly boom section; remove wear pads from the top, sides and bottom of the fly boom section.

16. When removing wire rope from fly boom section, push the cable into fly boom. Route wire rope back through holes in the side of the fly boom section.

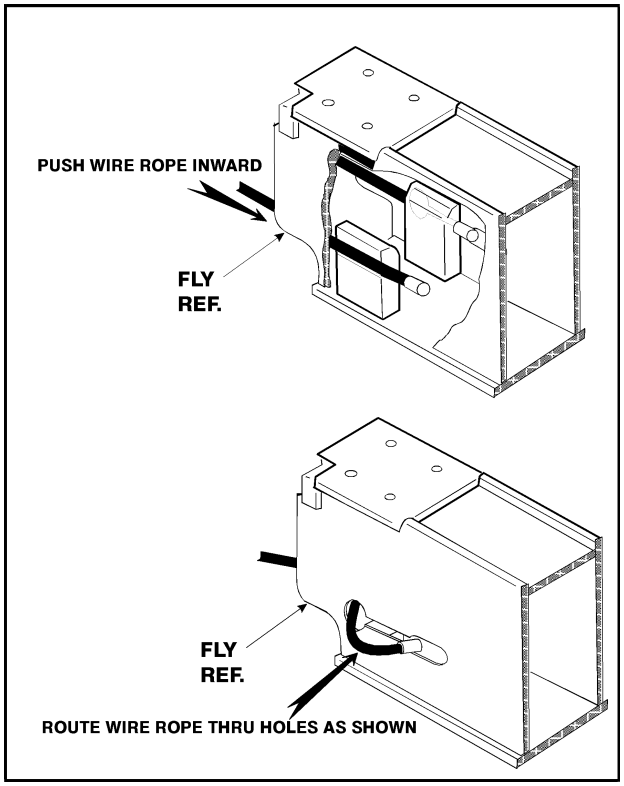


Figure 4-7. Disassembly Wire Rope Routing Procedure

Inspection

NOTE: *When inspecting pins and bearings Ref. to paragraph 2-39. Pins and Gar-Max Bearing Repair Guidelines.*

1. Inspect all sheaves (extend and retract wire ropes and telescope cylinder) for excessive groove wear, burrs or other damage. Replace sheaves as necessary.

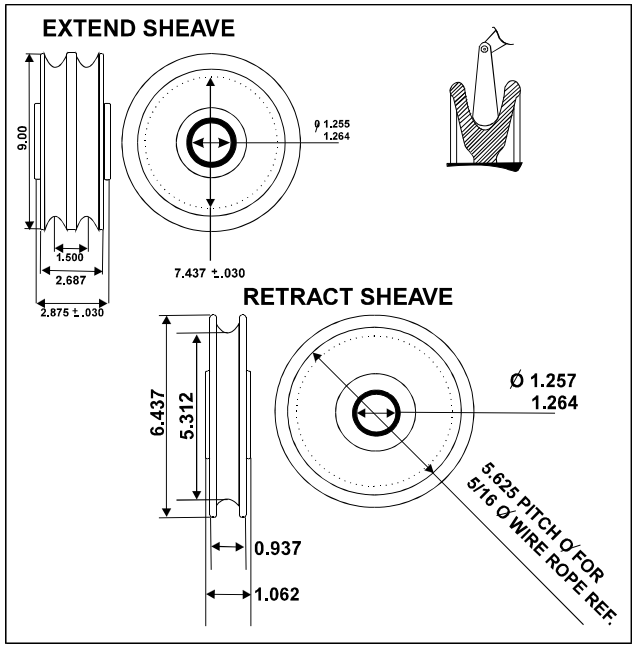


Figure 4-8. Dimension of Sheaves When New

2. Inspect extend and retract wire rope sheave bearings for wear, scoring, or other damage, and for ovality.

3. Inspect extend wire rope and retract wire rope sheave pins for scoring, tapering and ovality. Replace pins as necessary.

4. Inspect telescope cylinder sheave pin for scoring, tapering and ovality. Replace pins as necessary.

5. Inspect boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.

6. Inspect telescope cylinder attach point for scoring, tapering and ovality. Replace pins as necessary.

7. Inspect upper lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
8. Inspect inner diameter of boom pivot bushing for scoring, distortion, wear, or other damage. Replace bearing as necessary.
9. Inspect all wear pads for excessive wear or other damage. Replace pads when worn to within 1/8 inch (3.2 mm) of threaded insert.
10. Inspect extend and retract wire rope attach point components for cracks, stretching, distortion, or other damage. Replace components as necessary.
11. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
12. Inspect structural units of boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

Assembly

NOTE: *When installing fly section wear pads, install same number and thickness of shims as were removed during disassembly.*

1. Measure inside dimensions of the base and mid sections to determine the number of shims required for proper lift.
2. Measure inside dimensions of the mid section to determine the number of shims required for proper lift.
3. Install side, top and bottom wear pads to the aft end of fly section; shim evenly to the measurements of the inside of mid section.
4. Install retract wire ropes into aft end of fly section, route wire ropes thru holes in side of fly boom section and pull into slot.

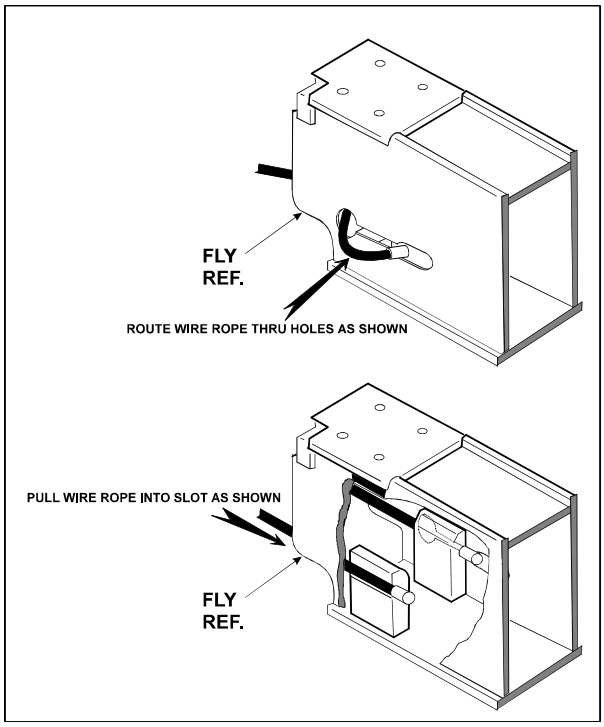


Figure 4-9. Routing Installation of Retract Wire Ropes

5. Install side, top and bottom wear pads to the aft end of mid section; shim evenly to the measurements of the inside of mid section.

⚠ CAUTION

WHEN ASSEMBLING BOOM SECTIONS, ENSURE THAT THE BOOM SLIDING TRAJECTORIES HAVE BEEN CLEARED OF CHAINS, TOOLS, AND OTHER OBSTRUCTIONS.

6. Shim the insides of the boom sections for a total of 1/16 inch (0.062) clearance (if the action is centered, there will be 1/32 clearance on each side).
7. Slide fly boom section into the mid boom section. Shim boom, if necessary, for a total of 1/16 inch (0.062) clearance.
8. Install wear pads into the forward position of the mid boom section. Shim boom, if necessary, for a total of 2/10 inch (0.20) clearance.
9. Properly position the retraction wire rope sheaves assemblies at the aft end of the mid boom section; ensure all sheave-to-mounting block attachment holes align. Install the sheave pins and secure them with mounting hardware. Position retract wire ropes onto the sheaves.

10. Install sheave guards to aft end of mid boom section and secure with mounting hardware.

11. Slide mid boom section into the base boom section. Allow the retraction wire ropes to trail between the bottom surfaces of boom sections. Shim boom, if necessary, for a total of 1/16 inch (0.062) clearance.

12. Install wear pads into the forward position of the base boom section. Shim boom, if necessary, for a total of 2/10 inch (0.20) clearance.

13. Install sheave block to bottom of base boom section and adjust block so that retract wire ropes do not come into contact with boom surfaces.

14. Install wire rope threaded ends thru attachment holes in the bottom of base boom section. Loosely install nuts and jam nuts onto the threaded ends of wire ropes.

15. Align the telescope cylinder barrel-to-sheave attachment point. Install extend sheave pin through the telescope cylinder barrel and sheave assembly; secure pin with mounting hardware.

16. Route extend wire ropes around extend sheave and secure wire ropes to the telescope cylinder.

17. Install extend wire rope mounting blocks to threaded ends of wire ropes. Loosely install nuts and jam nuts onto the threaded ends of wire ropes.

NOTE: *When installing wire ropes, care must be taken not to twist or cross the wire ropes.*

18. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the boom assembly.

⚠ CAUTION

WHEN INSERTING THE TELESCOPE CYLINDER INTO THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY INTO POSITION. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

19. Align the cylinder with the slots at aft end of mid boom section, then secure cylinder with mounting hardware.

20. Align holes in aft end of the fly boom section with holes in wire rope mounting block, then secure with mounting hardware.

21. Align holes in aft end of the mid boom section with holes in wire rope mounting block, then secure with mounting hardware.

NOTE: *Boom wire ropes must be torqued after installation of the boom assembly.*

22. Align holes in rod end of the telescope cylinder with holes in push bar. Install push bar pin and secure with mounting hardware.

23. Install the hydraulic lines and electrical cables, and the harnessing powertrack components as follows:

    a. Align holes in powertrack rail with attachment holes in side of the base boom section. Secure the rail with mounting hardware.

    b. Install powertrack to rail with mounting hardware.

    c. Attach push tube bracket to the side of the mid boom section with mounting hardware.

NOTE: *Do not over tighten attach bolt on push tube bracket. It should pivot freely.*

    d. Install slide block and wear pads to the powertrack rail with mounting hardware.

    e. Install powertrack to push tube with mounting hardware.

    f. Carefully feed the hoses and electrical cables through the aft end of the powertrack rail, powertrack and push tube.

    g. Ensure all hoses and cables are properly routed through the powertrack rail, powertrack and push tube. Tighten or install all clamping or securing apparatus to the hoses or cables, as necessary.

    h. Install powertrack cover and push tube rods with mounting hardware.

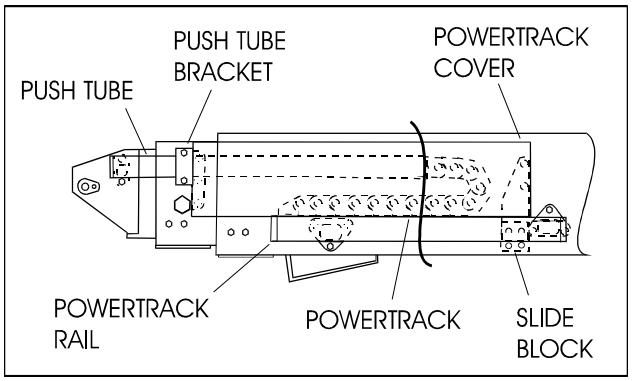


Figure 4-10. Reassembly of Components - Boom Powertrack Assembly

Installation

1. Using a suitable lifting device, position boom assembly on turntable so that the pivot holes in both boom and turntable are aligned.
2. Install boom pivot pin, ensuring that location of hole in pin is aligned with attach point on turntable.
3. If necessary, gently tap pin into position with soft headed mallet. Secure pin mounting hardware.
4. Align push bar pivot hole with pivot holes in turntable. Install push bar pivot pin, ensuring that location of hole in pin is aligned with attach point on turntable.
5. If necessary, gently tap pin into position with soft headed mallet. Secure pin mounting hardware.
6. Connect all wiring to the ground control box.
7. Connect all hydraulic lines running along side of boom assembly.
8. Using all applicable safety precautions, operate lifting device in order to position boom lift cylinder so that holes in the cylinder rod end and boom structure are aligned. Insert the lift cylinder pin, ensuring that location of hole in pin is aligned with attach point on boom.
9. Align holes in boom structure with hole in master cylinder. Insert the master cylinder pin, ensuring that location of hole in pin is aligned with attach point on boom.
10. Adjust retract and extend cables to the proper torque. Refer to Section 4.2, Boom Rope Torquing Procedures.
11. Using all applicable safety precautions, operate machine systems and raise and extend boom fully, noting the performance of the extension cycle.
12. Retract and lower boom, noting the performance of the retraction cycle.

4.2 BOOM ROPE TORQUING PROCEDURES

Torque Procedures

1. Position boom in fully down and fully retracted position.

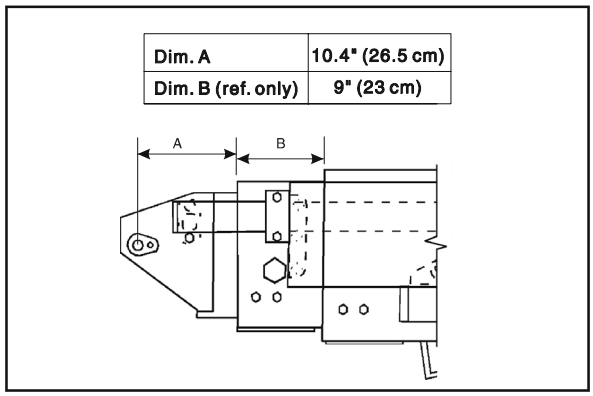


Figure 4-11. Dimensions of Boom Sections

2. Clamp both threaded ends of wire rope to prevent rotation.

NOTE: *Do not clamp on threads.*

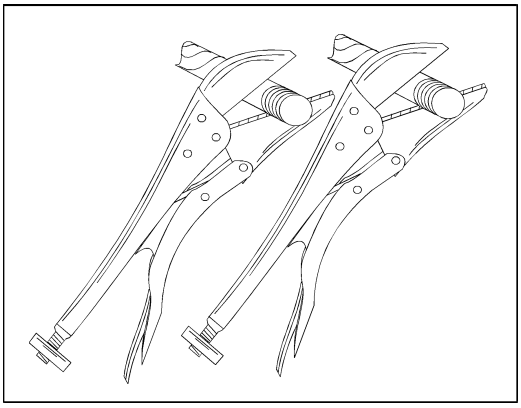


Figure 4-12. Clamping Wire Ropes

3. Install adjusting nuts (or remove nylon collar locknuts if re-adjusting) to both retract and extend wire ropes.
4. Torque retract adjusting nuts (platform end) to 15 ft. lbs. (20 Nm) alternating between the two wire ropes and keeping approximately the same amount of thread beyond the adjusting nut.

NOTE: *Do not allow wire rope to rotate. This may damage the wire rope.*

5. Repeat the torque procedure in step #4 to the extend wire ropes (turntable end).
6. Extend the boom 2 - 3 feet using the telescope function. Repeat step #4.
7. Retract the boom 1 - 2 feet using the telescope function. Do not bottom out telescope cylinder. Repeat step #5.
8. Extend the boom approximately 2 - 3 feet again and check torque on the retract wire ropes.
9. Retract the boom without bottoming out telescope cylinder and check torque on the extend wire ropes.

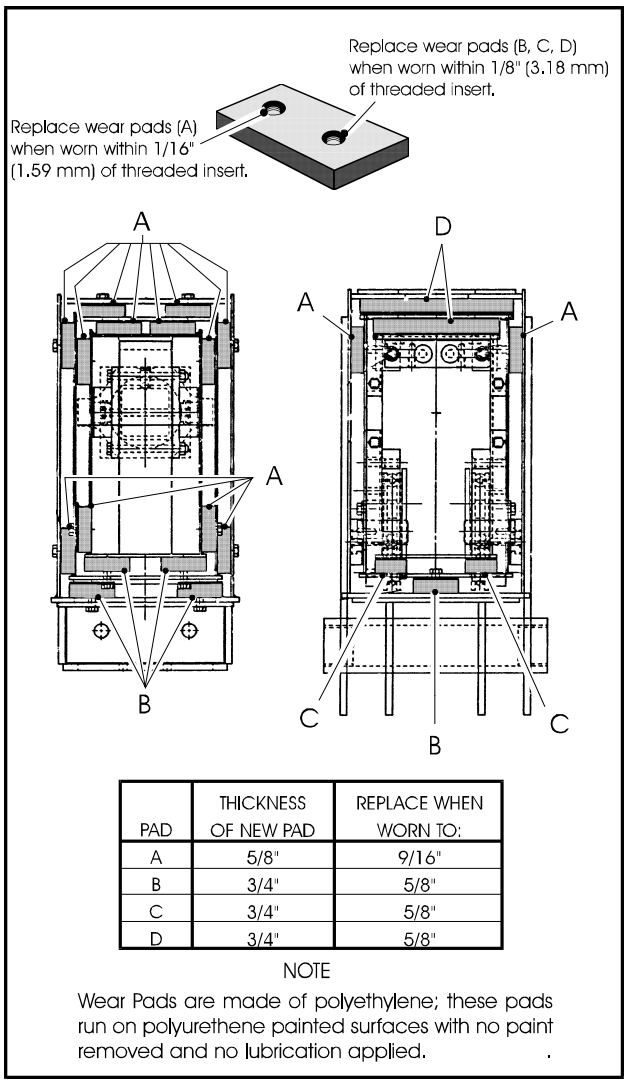
NOTE: *Step #8 and #9 may need to be repeated to equalize the torque on all 4 wire ropes.*

10. After all wire ropes have been properly torqued, install nylon collar locknuts. Remove all clamping devices and install all covers and guards. Check the boom for proper function.

4.3 WEAR PADS

Main Boom

1. Shim up wear pads to within 1/32 inch (.79 mm) tolerance between wear pad and adjacent surface.



PAD	THICKNESS OF NEW PAD	REPLACE WHEN WORN TO:
A	5/8"	9/16"
B	3/4"	5/8"
C	3/4"	5/8"
D	3/4"	5/8"

NOTE

Wear Pads are made of polyethylene; these pads run on polyurethene painted surfaces with no paint removed and no lubrication applied.

Figure 4-13. Location and Thickness of Wear Pads

2. Replace wear pads when worn within 1/16 inch (1.59 mm) and 1/8 inch (3.18 mm) - B, C, D of threaded insert. See Location and Thickness Of Wear Pads.
3. Adjusting wear pads, removing or adding shims, bolt length must also be changed.
   a. When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
   b. When shims are removed, shorter bolts must be used so bolt does not protrude from insert and come into contact with boom surface.

4.4 WIRE ROPE

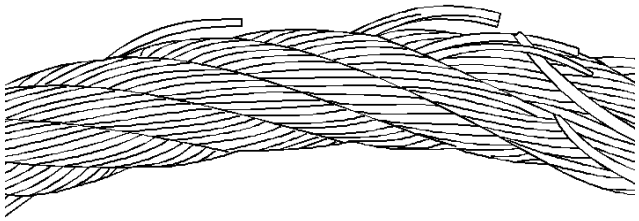
Each day before using the machine:

1. Raise the main boom to approximately horizontal.
2. Extend and retract the boom sections.
3. Check for delayed movement of the fly section, which indicates loose wire ropes.

Inspection

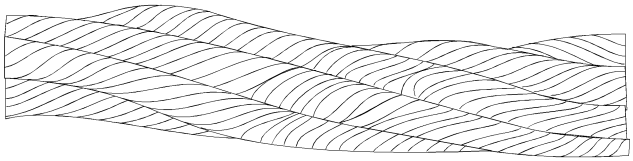
NOTE: *The pictures in this paragraph are just samples to show the replacement criteria of the rope.*

1. Inspect ropes for broken wires, particularly valley wire breaks and breaks at end terminations.



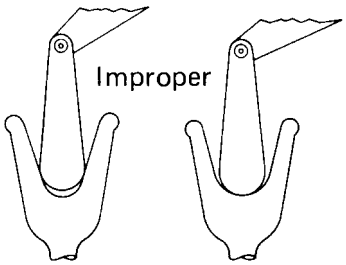
Flexing a wire rope can often expose broken wires hidden in valleys between strands.

2. Inspect ropes for corrosion.
3. Inspect ropes for kinks or abuse.



A kink is caused by pulling down a loop in a slack line during improper handling, installation, or operation.

4. Inspect sheaves for condition of bearings/pins. (See Dimension Of Sheaves for proper dimension.)
5. Inspect sheaves for condition of flanges. (See Dimension Of Sheaves for proper dimension.)
6. Inspect sheaves with a groove wearout gauge for excessive wear.



Observe the groove so that it may be clearly seen whether the contour of the gauge matches the contour of the bottom of the groove.

7. Ropes passing inspection should be lubricated with wire rope lubricant before reassembly.

Three Month Inspection

1. Remove boom covers and visually (with flashlight) inspect the ropes for rust, broken wires, frays, abuse, or any signs of abnormalities.
2. Check rope tension by deflecting the ropes by hand...properly tensioned ropes should have little or no movement.

Seven Year Inspection

1. Mandatory wire rope and sheave replacement.

Additional inspection required if:

1. Machine is exposed to hostile environment or conditions.
2. Erratic boom operation or unusual noise exists.
3. Machine is idle for an extended period.
4. Boom is overloaded or sustained a shock load.
5. Boom exposed to electrical arc...wires may be fused internally.

Replacement Criteria

1. Sheaves and wire rope must be replaced as sets.
2. Rusted or corroded wire ropes.
3. Kinked, “bird caged”, or crushed ropes.
4. Ropes at end of adjustment range.
5. Sheaves failing wearout gage inspection.
6. Ropes with 6 total broken wires in one rope lay, 3 in one strand in one rope lay, 1 valley break, or 1 break at any end termination.

4.5 LIMIT SWITCHES AND CAM VALVE ADJUSTMENT

Adjust switches and cam valve as shown in Limit Switches Adjustment.

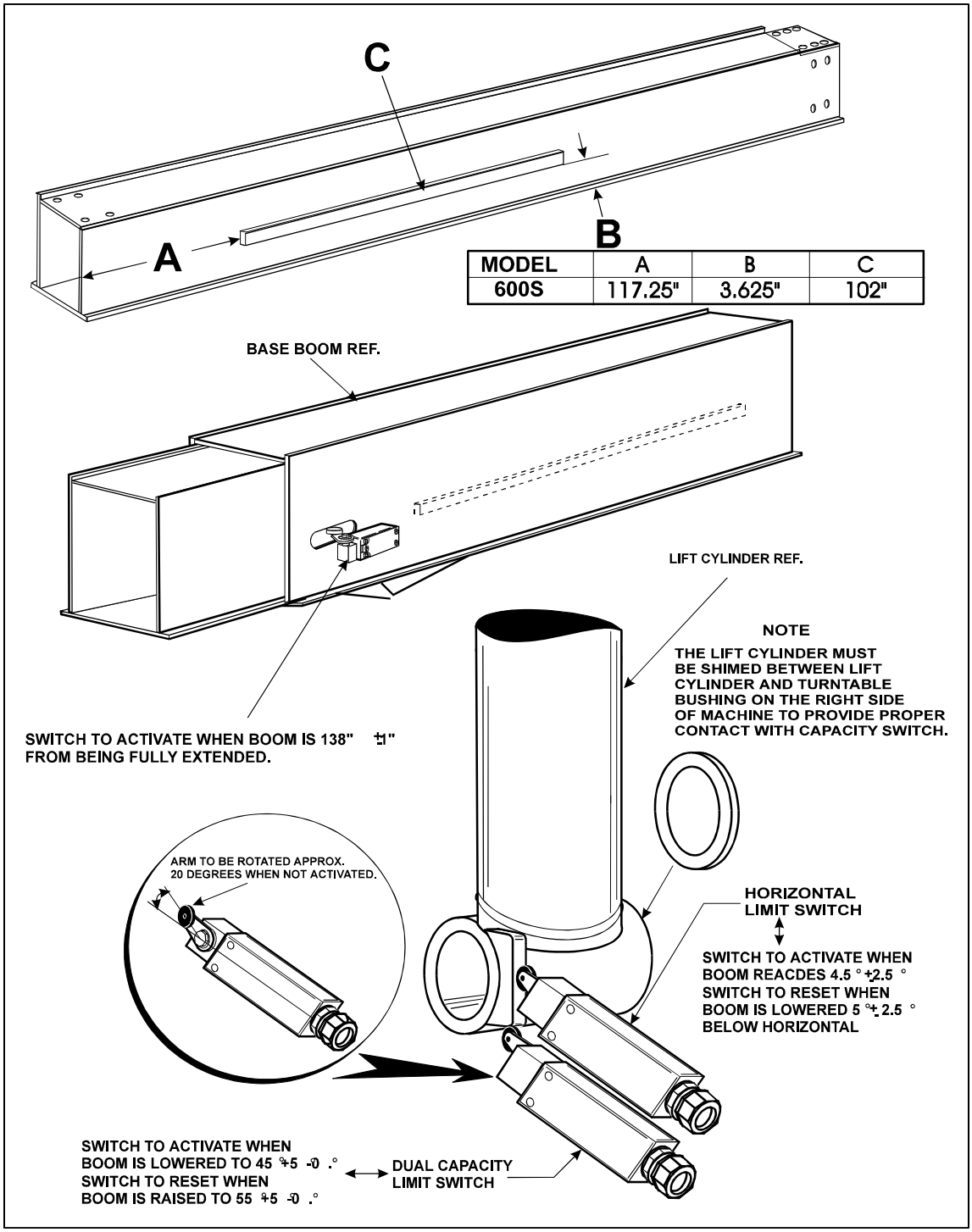


Figure 4-14. Limit Switches Adjustments

4.6 ROTATOR - HELAC

Disassembly

1. Place actuator on a clean workbench.
2. Remove all hydraulic fittings.
3. Using a suitable hammer and chisel remove the portion of end cap securing setscrew.

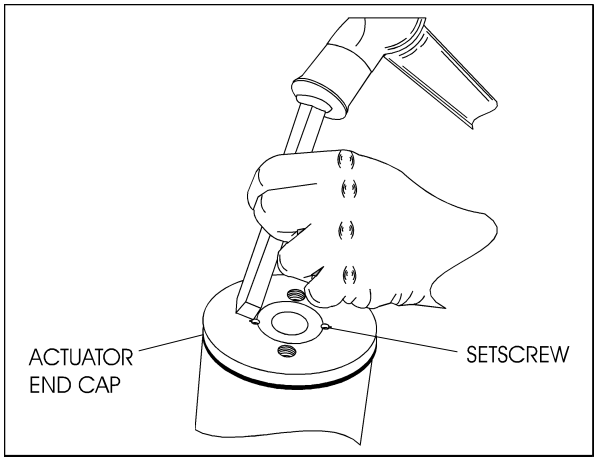


Figure 4-15. Removing Portion of End Cap

4. Using a torch, apply heat to the setscrews on the bottom of actuator.

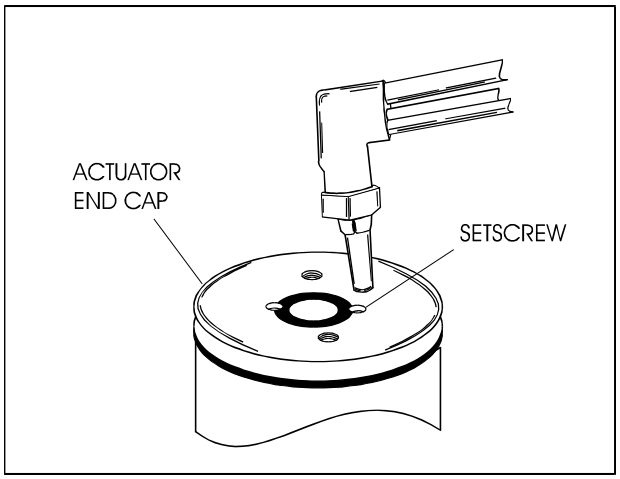


Figure 4-16. Heating Setscrew

5. Remove the two (2) setscrew (4) from bottom of actuator (1). Discard setscrew.

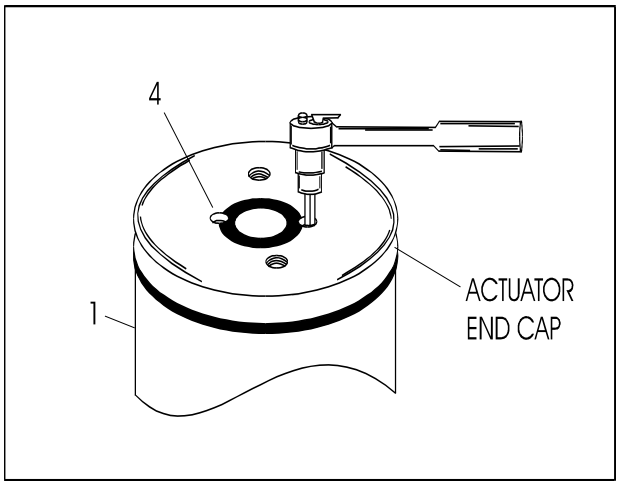


Figure 4-17. Removing Setscrew

6. Place two (2) 3/8"x16NC bolts in threaded holes in bottom of the actuator. Using a suitable bar, unscrew the end cap (5). Remove the end cap from actuator (1).

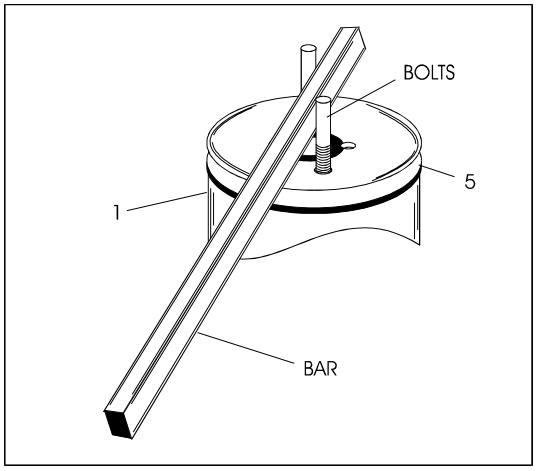


Figure 4-18. Removing End Cap

7. Remove the shaft (2) from piston sleeve (3) and the actuator housing (1).

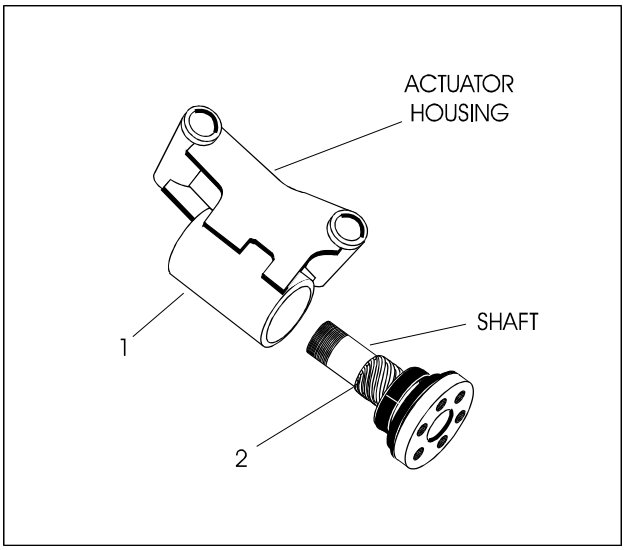


Figure 4-19. Removing Shaft from Housing

8. Remove piston sleeve (3) from housing (1).

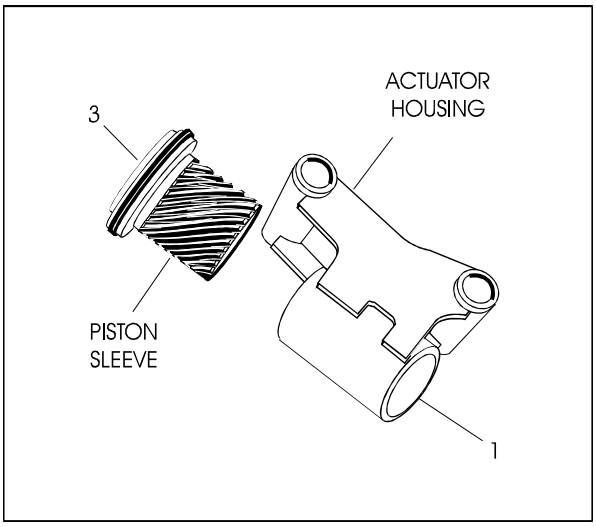


Figure 4-20. Removing Sleeve from Housing

9. Remove all seals and bearings from grooves. Discard seals.

Inspection

1. Clean all parts thoroughly.
2. Closely inspect all parts for excessive wear, cracks and chips. Replace parts as necessary.

NOTE: *A small amount of wear in the spline teeth will have little effect on the actuator strength. New spline sets are manufactured with a backlash of about 0.005 in. per mating set. After long service, a backlash of about 0.015 per set may still be acceptable in most cases, depending on the required accuracy of the application.*

3. Check the ring gear for wear and weld damage to the pins.
4. Inspect the cylinder bore for wear and scratches.

Assembly

NOTE: *Lubricate all seals and o-rings with clean hydraulic oil prior to assembly.*

1. Install new seal (7) and bearing (6) on the piston sleeve (3).

NOTE: *Apply a coat of grease to the thrust ring before sliding onto the shaft.*

2. Install new seal (8), thrust ring (10) and bearing (9) on shaft (2).

NOTE: *Apply a coat of grease to the thrust ring before sliding onto the end cap.*

3. Install new seals (11), back-up ring (12), cap bearing (13), bearing packing (14) and thrust ring (10) on end cap (5).
4. Place the actuator in the vertical position, install the piston sleeve (3) in timed relation to the housing (1).

⚠ CAUTION

DO NOT MISALIGN THE SLEEVE TOO MUCH ANY ONE WAY, AS IT WILL MARK THE CYLINDER BORE.

NOTE: *The timing marks (the small punch marks on the face of each gear), must be aligned for proper shaft orientation. (See Actuator Timing.)*

5. Install the shaft (2) into housing (1) by aligning the proper punched timing marks. (See Actuator Timing.)
6. Temporarily tape the threaded portion of the shaft will help installation past the shaft seals (masking tape).
7. The end cap (5) is torqued to 40 - 50 ft. lbs. (54 - 68 Nm), such that the actuator begins rotation at approximately 100 psi (6.895 Bar) pressure.
8. The end cap must be secured against the shaft by installing axial set screws (4).

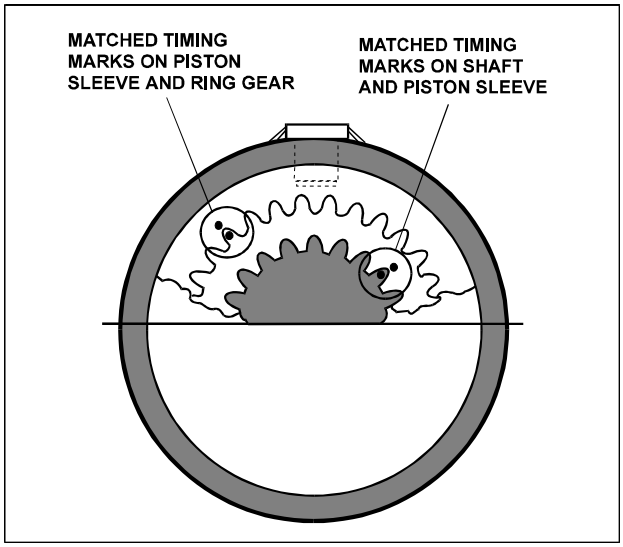
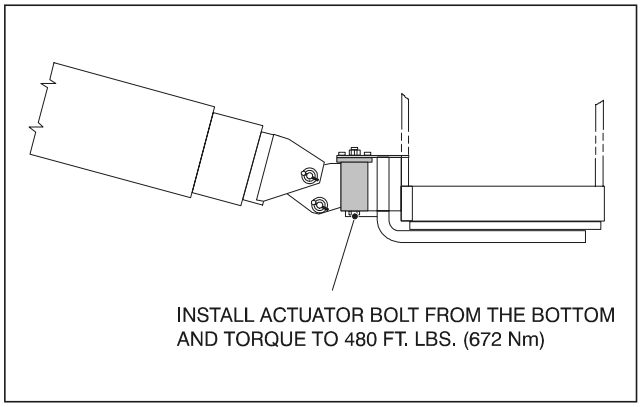
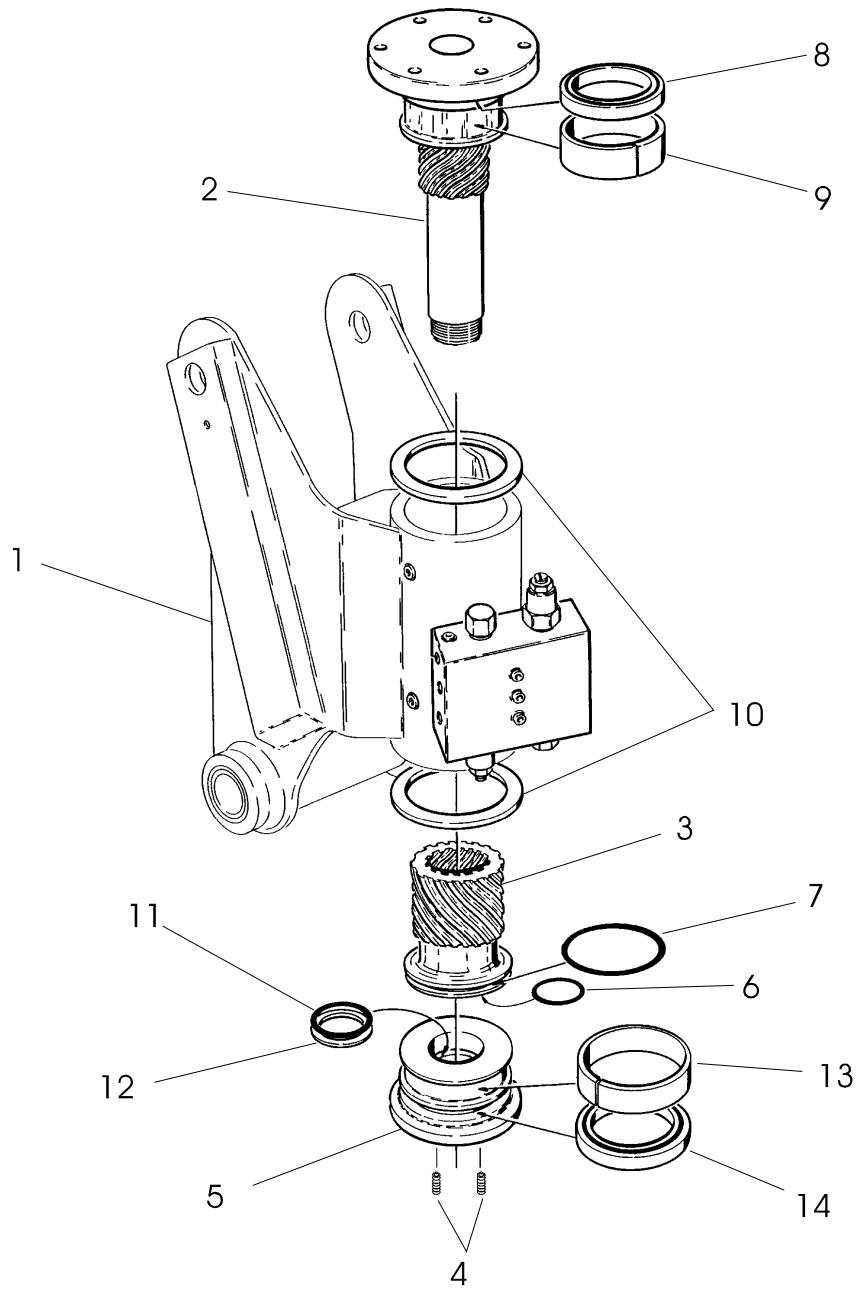


Figure 4-21. Actuator Timing





1. Housing/Ring Gear Assembly
2. Shaft
3. Piston/Sleeve Assembly
4. Setscrews
5. End Cap
6. Rod Seal
7. Piston Seal
8. Bearing Packing
9. Shaft Bearing
10. Thrust Ring
11. Cap Seal
12. Back-up Ring
13. Cap Bearing
14. Bearing Packing

Figure 4-22. Rotator Assembly (Helac)

4.7 DRIVE CARD SETUP PROCEDURES

NOTE: *The following procedures are to be used as a beginning basis for controller adjustment. After completing the procedure, final adjustments are to be made based on the machines function speed*

Lift, Swing, and Drive Cards

1. Center the input potentiometers. Power up the card, but do not start the engine. Place the common lead of a voltmeter on pin #6 and place the other lead on pin #8. Rotate the potentiometer, leaving the joystick in the center position, until the voltmeter reads 2.5 volts. Secure the set screw on the potentiometer. When the potentiometer is centered and the joystick is in the center position, LED #3 should not be illuminated.
2. Install test harness JLG P/N 4922012.
3. Set the minimum and maximum currents. The input potentiometer must be centered before continuing with this procedure. Power up the card, but do not start the engine. Place the current meter in series with the “A” output. Turn P3 counter clockwise until the adjustment potentiometer starts to click. This will set to maximum current to its lowest value. Move the joystick until LED #3 illuminates and hold the stick in this position. Adjust P4 until the meter equals the setting given in table #1. Rotating the adjustment potentiometer clockwise will increase the current. This will set the minimum current setting for the “A” output. To set the maximum current for the “A” output, hold the joystick in its maximum position. Turn P3 clockwise until the meter reading equals the setting in table #1. Follow the same procedure for the “B” output. Use P8 for the minimum current adjustment and P7 for the maximum current adjustment.
4. Set the ramp up and the ramp down times. Step 2 must be performed before continuing with procedure. Power up the card, but do not start the engine. Place the current meter in series with the “A” output. Move the joystick from the center position to the extreme position. Watch the meter for the time it takes the output to go to from 0 current to maximum current. This is the ramp up time. Adjust P1 until this time matches the time given in table 2. Rotating the adjustment potentiometer clockwise will increase the ramp time. To set the ramp down time, hold the joystick in the extreme position. Release the joystick and watch the meter for the time it takes the output to go from the maximum current setting to 0 current. Adjust P2 until this time matches the time in table 2. Rotating the adjustment potentiometer clockwise will increase the ramp time. Follow the same procedure for the “B” output. Use P5 for the ramp up adjustment and P6 for the ramp down adjustment.

Flow Control Card

1. Set the input potentiometer. Power up the card, but do not start the engine. Place the common lead of a voltmeter on pin #15 and place the other lead on pin #8. Rotate the potentiometer and verify the input to the card is 3.8 volts when the input potentiometer is in its minimum position. Rotate the input potentiometer to its maximum position and verify the input to the card is 0 volts.
2. Set the minimum and maximum current settings. The input potentiometer must function properly before continuing with this procedure. Turn P3 counter clockwise until the adjustment pot starts clicking. Place a current meter in series with the “A” output. Rotate the input potentiometer to its minimum setting and operate the telescope function. Adjust P4 until the meter reading matches the setting in table 1. This sets the minimum current setting for the card. Rotate the input potentiometer to its extreme position and operate the telescope function. Turn P3 clockwise until the meter reading matches the setting in Table 1. This sets the maximum current for the card.
3. Set the ramp up and the ramp down times. Step 2 must be completed before continuing with this procedure. Power up the card, but do not start the engine. Place the current meter in series with the “A” output. Turn the input potentiometer to its extreme position and operate the telescope function. Watch the meter for the time it takes the output to go from 0 current to maximum current. This is ramp up time. Adjust P1 until this time matches the time in table 2. Rotating the adjustment potentiometer clockwise will increase ramp time. To set the ramp down time, hold the telescope function switch and watch the time it takes the output to go from the maximum current down to 0 current. This is the ramp down time. Adjust P2 until this time matches the setting in table

2. Rotating the adjustment potentiometer clockwise will increase the ramp time.

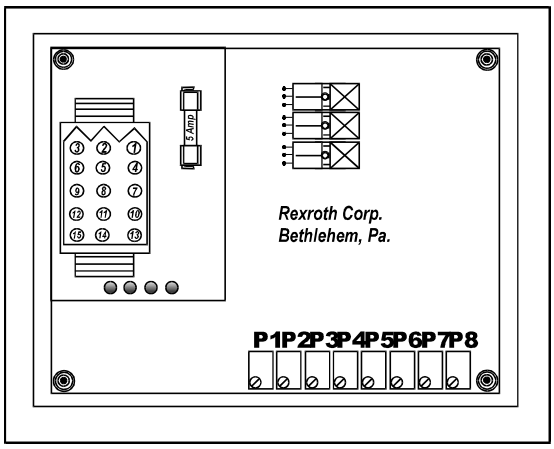


Figure 4-23. Control Card

Table 4-1. Flow Control Card Settings

Function	Minimum Current	Maximum Current
Lift Up	450 to 55o mA	1400 to 1500 mA
Lift Down	450 to 550 mA	1400 to 1500 mA
Swing Right	450 to 550 mA	1400 to 1500 mA
Swing Left	450 to 550 mA	1400 to 1500 mA
Flow Control	750 to 850 mA	450 to 550 mA
Drive Forward	40 to 60 mA	150 to 200 mA
Drive Reverse	40 to 60 mA	150 to 200 mA

Table 4-2. Flow Control Card Ramp Time

Function	Ramp Time
Lift Up	Ramp Up Time = 4:00 sec. Ramp Down Time = 3:00 sec.
Lift Down	Ramp Up Time = 4:00 sec. Ramp Down Time = 3:00 sec.
Swing Right	Ramp Up Time = 4:00 sec. Ramp Down Time = 3:00 sec.
Swing Left	Ramp Up Time = 4:00 sec. Ramp Down Time = 3:00 sec.
Drive Forward	Ramp Up Time = 4:30 sec. Ramp Down Time = 2:30 sec.
Drive Reverse	Ramp Up Time = 4:30 sec. Ramp Down Time = 2:30 sec.
Flow Control	Ramp Up Time = 3:00 sec. Ramp Down Time = 0:00 sec.

Table 4-3. Function Speeds

Function	Function Speed In Seconds
Telescope	
Extend	48-61
Retract	24-32
Lift	
Up	46-60
Down	33-43
Swing Speed	
Full 360	79-101
Platform Rotation	
Left	22-30
Right	22-30
Drive Speed	
	32-36 @ 200ft.

4.8 FOOT SWITCH ADJUSTMENT

Adjust so that functions will operate when pedal is at center of travel. If switch operates within last 1/4 in. (6.35 mm) of travel, top or bottom, it should be adjusted.

SECTION 5. HYDRAULICS

5.1 CYLINDERS - THEORY OF OPERATION

Systems Incorporating Double Acting Cylinders

Cylinders are of the double acting type. Systems incorporating double acting cylinders are as follows: Slave Level, Master Level, Lift, Telescope, Axle Lockout and Steer. A double acting cylinder is one that requires oil flow to operate the cylinder rod in both directions. Directing oil (by actuating the corresponding control valve to the piston side of the cylinder) forces the piston to travel toward the rod end of the barrel, extending the cylinder rod (piston attached to rod). When the oil flow is stopped, movement of rod will stop. By directing oil to the rod side of the cylinder, the piston will be forced in the opposite direction and the cylinder rod will retract.

Systems Incorporating Holding Valves

Holding valves are used in the - Lift, Telescope, Lockout, and Slave Level circuits to prevent retraction of the cylinder rod should a hydraulic line rupture or a leak develop between the cylinder and its related control valve.

5.2 VALVES - THEORY OF OPERATION

Solenoid Control Valve - Rexroth

Control valves used are four-way three-position solenoid valves of the sliding spool design. When a circuit is activated and the control valve solenoid energizes, the spool is shifted and the corresponding work port opens to permit oil flow to the component in the selected circuit with the opposite work port opening to reservoir. Once the circuit is deactivated (control returned to neutral) the valve spool returns to neutral (center) and oil flow is then directed through the valve body and returns to reservoir. A typical control valve consist of the valve body, sliding spool, and two solenoid assemblies. The spool is machine fitted in the bore of the valve body. Lands on the spool divide the bore into various chambers, which, when the spool is shifted, align with corresponding ports in the valve body open to common flow. At the same time other ports would be blocked to flow. The spool is spring loaded to center position, therefore when the control is released, the spool automatically returns to neutral, prohibiting any flow through the circuit.

Relief Valves

Relief valves are installed at various points within the hydraulic system to protect associated systems and components against excessive pressure. Excessive pressure can be developed when a cylinder reaches its limit of travel and the flow of pressurized fluid continues from the system control. The relief valve provides an alternate path for the continuing flow from the pump, thus preventing rupture of the cylinder, hydraulic line or fitting. Complete failure of the system pump is also avoided by relieving circuit pressure. The relief valve is installed in the circuit between the pump outlet (pressure line) and the cylinder of the circuit, generally as an integral part of the system valve bank. Relief pressures are set slightly higher than the load requirement, with the valve diverting excess pump delivery back to the reservoir when operating pressure of the component is reached.

5.3 CYLINDER CHECKING PROCEDURE

NOTE: *Cylinder check must be performed anytime a system component is replaced or when improper system operation is suspected.*

Cylinders Without Counterbalance Valves - Master Cylinder and Steer Cylinder

1. Using all applicable safety precautions, activate engine and fully extend cylinder to be checked. Shut down engine.
2. Carefully disconnect hydraulic hoses from retract port of cylinder. There will be some initial weeping of hydraulic fluid which can be caught in a suitable container. After the initial discharge, there should be no further drainage from the retract port.
3. Activate engine and extend cylinder.
4. If cylinder retract port leakage is less than 6-8 drops per minute, carefully reconnect hose to port and retract cylinder. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repair must be made.
5. With cylinder fully retracted, shut down engine and carefully disconnect hydraulic hose from cylinder extend port.
6. Activate engine and retract cylinder. Check extend port for leakage.
7. If extend port leakage is less than 6-8 drops per minute, carefully reconnect hose to extend port, than activate cylinder through one complete cycle and check for leaks. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repairs must be made.

Cylinders With Dual Counterbalance Valves

Slave Level, Lift, and Telescope.

⚠ IMPORTANT

OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.

1. Using all applicable safety precautions, activate hydraulic system.

⚠ WARNING

IF WORKING ON THE PLATFORM LEVEL CYLINDER, STROKE PLATFORM LEVEL CYLINDER FORWARD UNTIL PLATFORM SITS AT A 45 DEGREES ANGLE.

2. Shut down hydraulic system and allow machine to sit for 10-15 minutes. If machine is equipped with bang-bang or proportional control valves, turn IGNITION SWITCH to ON, move control switch or lever for applicable cylinder in each direction, then turn IGNITION SWITCH to OFF. If machine is equipped with hydraulic control valves, move control lever for applicable cylinder in each direction. This is done to relieve pressure in the hydraulic lines. Carefully remove hydraulic hoses from appropriate cylinder port block.
3. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After the initial discharge, there should be no further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, the counterbalance valve is defective and must be replaced.
4. To check piston seals, carefully remove the counterbalance valve from the retract port. After initial discharge, there should be no further leakage from the ports. If leakage occurs at a rate of 6-8 drops per minute or more, the piston seals are defective and must be replaced.
5. If no repairs are necessary or when repairs have been made, replace counterbalance valve and carefully connect hydraulic hoses to cylinder port block.
6. If used, remove lifting device from upright or remove prop from below main boom, activate hydraulic system and run cylinder through one complete cycle to check for leaks.

5.4 CYLINDER REPAIR

NOTE: *The following are general procedures that apply to all of the cylinders on this machine. Procedures that apply to a specific cylinder will be so noted.*

Disassembly

⚠ IMPORTANT

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

⚠ WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. If applicable, remove the cartridge-type holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture. Tap around the outside of the cylinder head retainer with a suitable hammer to shatter the loctite seal.

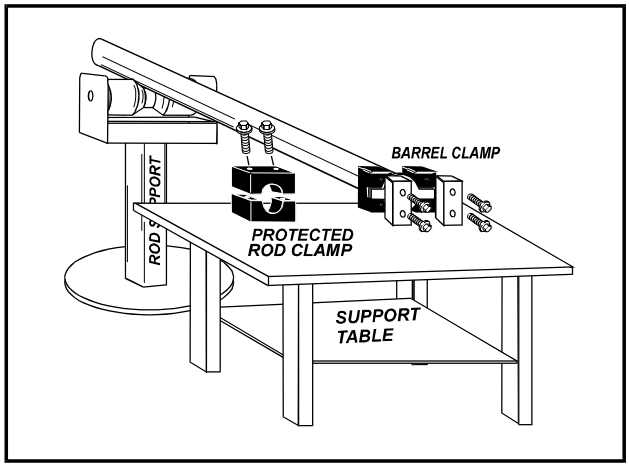


Figure 5-1. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the eight (8) cylinder head retainer cap screws, and remove cap screws from cylinder barrel.

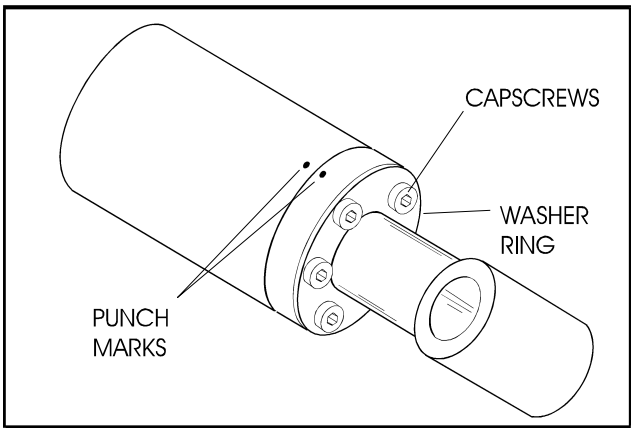
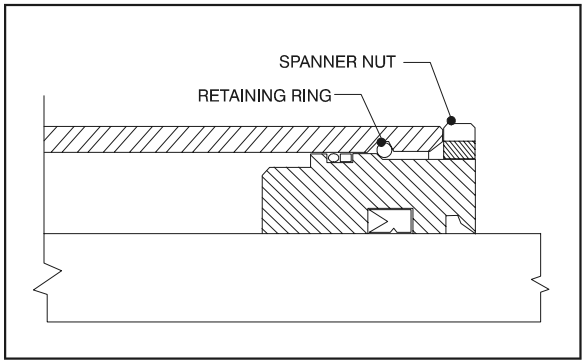


Figure 5-2. Cap Screw Removal

NOTE: *Steps 6 and 7 apply only to the steer cylinder.*

6. Using a spanner wrench, loosen the spanner nut retainer, and remove spanner nut from cylinder barrel.

7. Being careful not to mar the surface of the rod, use a punch or wooden dowel and hammer to drive the rod guide about one inch down into the cylinder bore. Using a screw driver, carefully push one end of the round retaining ring back towards the inside of the cylinder and then slip the screwdriver tip under that end. Pull the ring out of the groove toward the wall mouth. Once one end of the retaining ring is free from the groove, the remainder can be easily pried free using ones fingers or pliers.



8. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

⚠ IMPORTANT

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

9. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

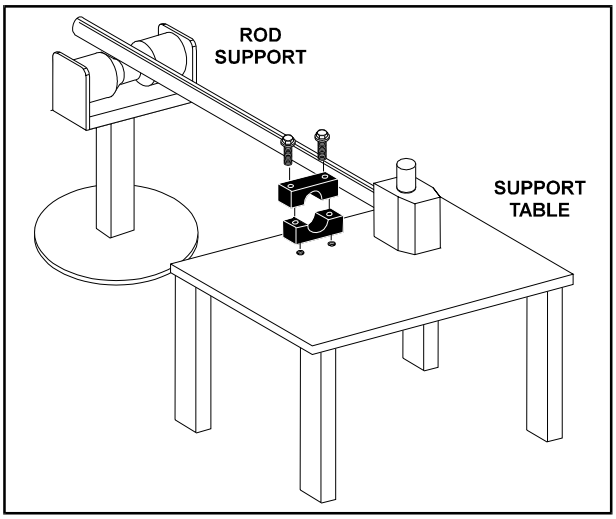


Figure 5-3. Cylinder Rod Support

10. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.

NOTE: *Step 11 applies only to the steer cylinder.*

11. Loosen and remove nut which attaches the piston to the rod, and remove the piston.

12. Loosen and remove the cap screw(s), if applicable, which attach the tapered bushing to the piston.

13. Insert the cap screw(s) in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the cap screw(s) until the bushing is loose on the piston.

14. Remove the bushing from the piston.

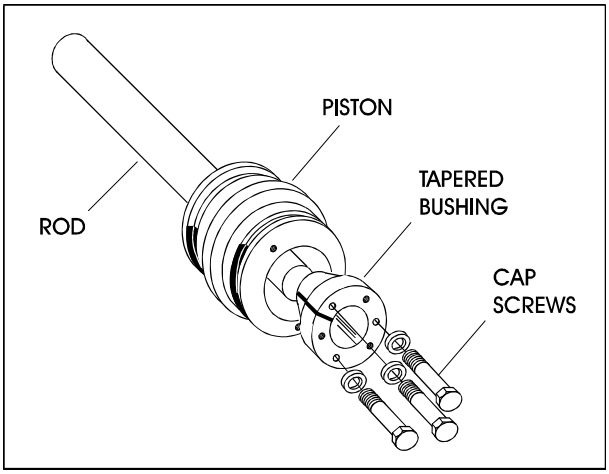


Figure 5-4. Tapered Bushing Removal

15. Screw the piston CCW, by hand, and remove the piston from cylinder rod.
16. Remove and discard the piston o-rings, seal rings, and backup rings.
17. Remove piston spacer, if applicable, from the rod.
18. Remove the rod from the holding fixture. Remove the cylinder head gland and retainer plate, if applicable. Discard the o-rings, back-up rings, rod seals, and wiper seals.

Cleaning and Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of the steel bushing with WD40 prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: *Install pin into the Gar-Max bearing dry. Lubrication is not required with nickel plated pins and bearings.*

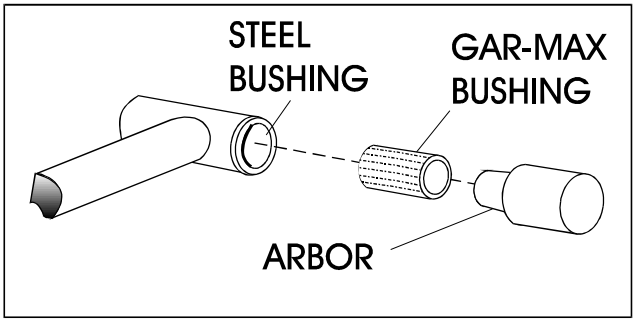


Figure 5-5. Gar-Max Bearing Installation

14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
17. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

Apply a light film of hydraulic oil to all components prior to assembly.

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

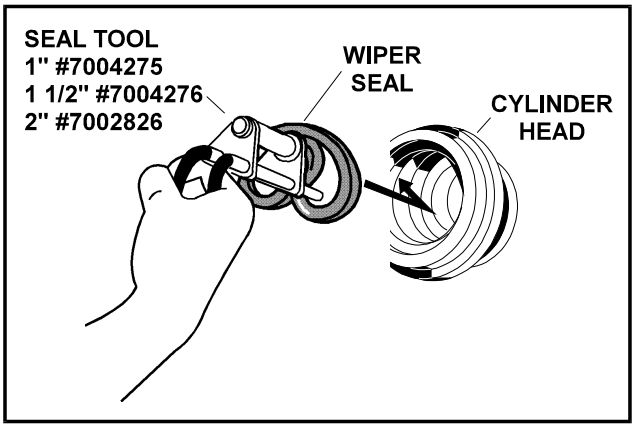


Figure 5-6. Rod Seal Installation

⚠ IMPORTANT

WHEN INSTALLING 'POLY-PAK' PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO WIPER SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

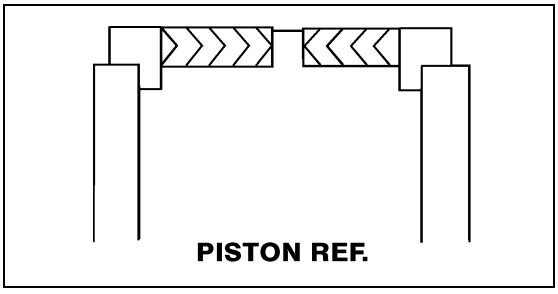


Figure 5-7. Poly-Pak Piston Seal Installation

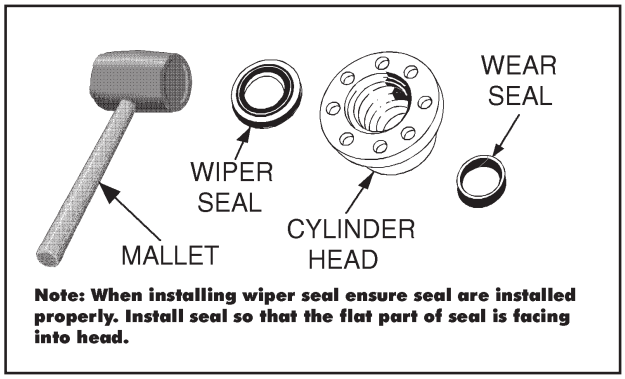


Figure 5-8. Wiper Seal Installation

1. Place a new "o"ring and back-up seal in the applicable outside diameter groove of the cylinder head.

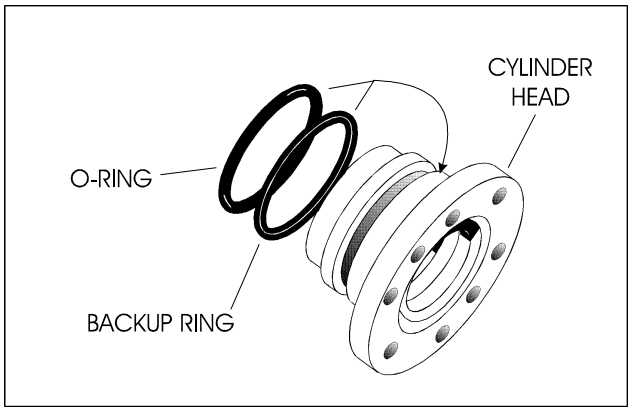


Figure 5-9. Installation of Head Seal Kit

2. Install washer ring onto rod, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
3. Carefully slide the piston spacer on the rod.

NOTE: *Upper telescope cylinder piston has an o-ring installed inside the spacer.*

4. If applicable, correctly place a new o-ring and back-up rings in the inner piston diameter groove.

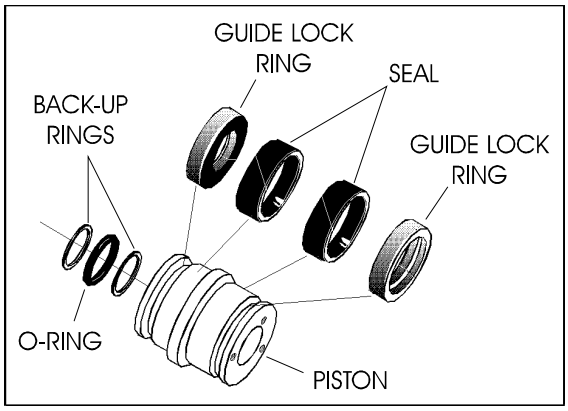


Figure 5-10. Piston Seal Kit Installation

5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
7. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

NOTE: *When installing the tapered bushing, piston and mating end of rod must be free of oil.*

⚠ WARNING

WHEN REBUILDING THE MASTER, SLAVE, LIFT, OR TELESCOPE CYLINDERS, APPLY LOCTITE #242 TO TAPERED BUSHING BOLTS, THEN TIGHTEN SECURELY. (TABLE 5-1, CYLINDER HEAD AND TAPERED BUSHING TORQUE SPECIFICATIONS).

8. Install the bolts in tapered bushing using loctite #242. (See Table 5-1, Cylinder Head and Tapered Bushing Torque Specifications.)

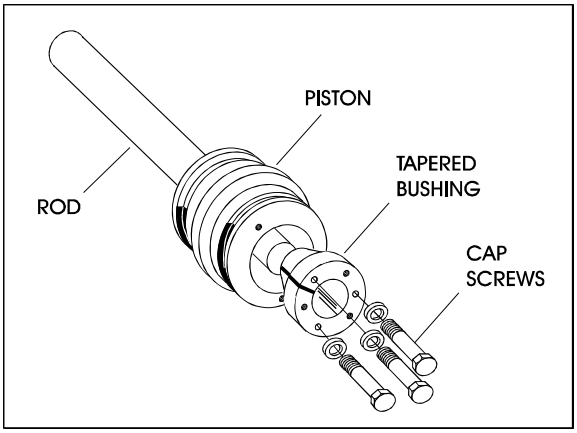


Figure 5-11. Tapered Bushing Installation

9. Remove the cylinder rod from the holding fixture.
10. Place new guide locks and seals in the applicable outside diameter grooves of the cylinder piston. (See Figure 5-10., Piston Seal Kit Installation).
11. Position the cylinder barrel in a suitable holding fixture.

⚠ IMPORTANT

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

12. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
13. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

14. Secure the cylinder head gland using the washer ring and socket head bolts. (Table 5-1, Cylinder Head and Tapered Bushing Torque Specifications.)

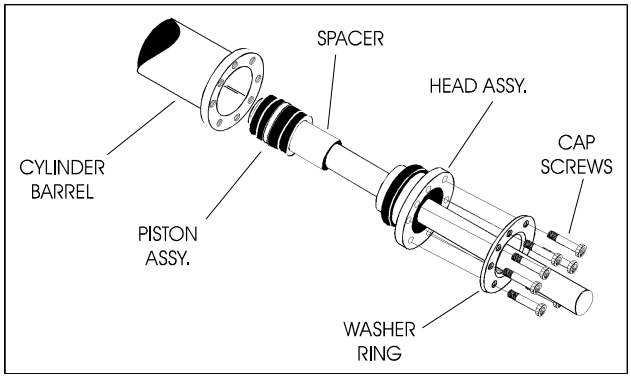


Figure 5-12. Rod Assembly Installation

15. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.

16. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. (See Table 5-2, Holding Valve Torque Specifications).

Table 5-1. Cylinder Head and Tapered Bushing Torque Specifications

Description	Head Torque Value (Wet)	Tapered Bushing Torque Value (Wet)
Lift Cylinder	275 ft. lbs. (373 Nm)	30 ft. lbs. (41 Nm)
Slave Cylinder	30 ft. lbs. (41 Nm)	5 ft. lbs. (9 Nm)
Master Cylinder	30 ft. lbs. (41 Nm)	5 ft. lbs. (9 Nm)
Telescope Cylinder	50 ft. lbs. (68 Nm)	9 ft. lbs. (12 Nm)
Lockout Cylinder	80 ft. lbs. (109 Nm)	N/A
Steer Cylinder Piston Nut Torque Specifications		
Steer Cylinder	LBS.	NM
	150 ft. lbs	204 Nm

Table 5-2. Holding Valve Torque Specifications

Description	Torque Value
SUN - 7/8 HEX M20 X 1.5 THDS.	30-35 ft. lbs. (41-48 Nm)
SUN - 1 1/8 HEX 1 -14 UNS THDS.	45-50 ft. lbs. (61-68 Nm)
SUN - 1 1/4 HEX M36 X 2 THDS.	150-160 ft. lbs. (204-217 Nm)
RACINE - 1 1/8 HEX 1 1/16 - 12 THDS.	50-55 ft. lbs. (68-75 Nm)
RACINE - 1 3/8 HEX 1 3/16 - 12 THDS.	75-80 ft. lbs. (102-109 Nm)
RACINE - 1 7/8 HEX 1 5/8 - 12 THDS.	100-110 ft. lbs. (136-149 Nm)

5.5 CYLINDER REMOVAL AND INSTALLATION

⚠ CAUTION

IF THE CYLINDER IS TO BE TESTED PRIOR TO INSTALLATION ON THE MACHINE, EXTREME CARE SHOULD BE USED TO INSURE THAT THE OUTER END OF THE ROD IS SUPPORTED. USE EITHER A TRAVELING OVERHEAD HOIST, FORK-LIFT, OR OTHER MEANS TO SUPPORT THE OVERHANGING WEIGHT OF THE EXTENDING ROD.

Main Boom Telescope Cylinder Removal

1. Place machine on a flat and level surface, with main boom in the horizontal position.
2. Shut down engine. Support main boom basket end with a prop.

⚠ CAUTION

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID THE ENTRY OF CONTAMINANTS INTO THE SYSTEM.

3. Tag and disconnect hydraulic lines to telescope cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
4. Remove the hardware securing cover plate on bottom of the base boom section and remove cover.

NOTE: *Do not allow cable to rotate. This may damage the cable.*

5. Clamp both threaded ends of cable to prevent rotation. Note: Do not clamp on threads. Remove jam nuts and loosen adjustment nuts so there is slack in the cables.
6. Remove the hardware securing push bar to turntable and telescope cylinder.
7. Using a suitable brass drift, carefully drive the push bar pins from the telescope cylinder rod and turntable.
8. Remove hardware securing cable adjustment block to aft end of the base boom section and remove block.
9. Remove hardware securing telescope cylinder to aft end of the mid boom section.

⚠ CAUTION

WHEN REMOVING THE TELESCOPE CYLINDER FROM THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY INTO POSITION: DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

10. Remove bolts securing cable attach bar to top of fly boom section.
11. Pull the telescope cylinder and cables partially from aft end of the base boom section; secure the cylinder with a suitable sling and lifting device at approximately the center of gravity.
12. Carefully remove the telescope cylinder and sheave assembly. Place telescope cylinder on a suitable trestle.

Main Boom Telescope Cylinder Installation

1. Route extend cables around extend sheave and secure cables to the telescope cylinder.
2. Install extend cables mounting blocks to threaded ends of cables. Loosely install nuts and jam nuts onto the threaded end of cables.

NOTE: *When installing cables care must be taken not to twist or cross the cables.*

3. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the boom assembly.
4. Install extend cable mounting blocks to threaded ends of cables. Loosely install nuts and jam nuts onto the threaded ends of cables.

NOTE: *When installing cables, care must be taken not to twist or cross the cables.*

5. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the boom assembly.

⚠ CAUTION

WHEN INSERTING THE TELESCOPE CYLINDER INTO THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY INTO POSITION: DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

6. Carefully install the telescope cylinder barrel end support into slots in mid boom and secure with blocks and bolts. Use Loctite #242 on bolts.
7. Align holes in aft end of the fly boom section with holes in cable mounting block, then secure with mounting hardware.
8. Align holes in aft end of the base boom section with holes in cable mounting block, then secure with mounting hardware.
9. Remove cylinder port plugs and hydraulic line caps and correctly attach lines to cylinder ports.
10. Align holes in rod end of the telescope cylinder with holes in push bar. Install push bar pin and secure with mounting hardware.
11. Align holes in push bar with holes in turntable. Install push bar pin and secure with mounting hardware.

NOTE: *Boom cables must be torqued after installation of the telescope cylinder. (See Boom Rope Torquing Procedures.)*

Boom Lift Cylinder Removal

1. Place the machine on a flat and level surface. Start the engine and place the main boom in the horizontal position. Shut down engine and prop the boom.
2. Remove the hardware retaining the cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.
3. Using auxiliary power, retract the lift cylinder rod completely.
4. Disconnect, cap and tag the main boom lift cylinder hydraulic lines and ports.
5. Remove barrel end attach pin retaining hardware. Using a suitable brass drift drive out the barrel end attach pin from the turntable.
6. Remove the cylinder from the turntable and place in a suitable work area.

Boom Lift Cylinder Installation

1. Install lift cylinder in place using suitable slings or supports, aligning attach pin mounting holes on the turntable.
2. Using a suitable drift, drive the barrel end attach pin through the mounting holes in the lift cylinder and the turntable. Secure in place with the pin retaining hardware.
3. Remove cylinder port plugs and hydraulic line caps and correctly attach lines to cylinder ports.
4. Using auxiliary power, extend the cylinder rod until the attach pin hole aligns with those in the boom. Using a suitable soft mallet, drive the cylinder rod attach pin through the boom and lift cylinder. Secure the pin in place with attaching hardware.
5. Remove boom prop and overhead crane. Activate hydraulic system.
6. Using all applicable safety precautions, operate the boom functions. Check for correct operation and hydraulic leaks. Secure as necessary.
7. Check fluid level of hydraulic tank and adjust as necessary.

5.6 VARIABLE DISPLACEMENT PUMP (M46 SERIES)

Troubleshooting

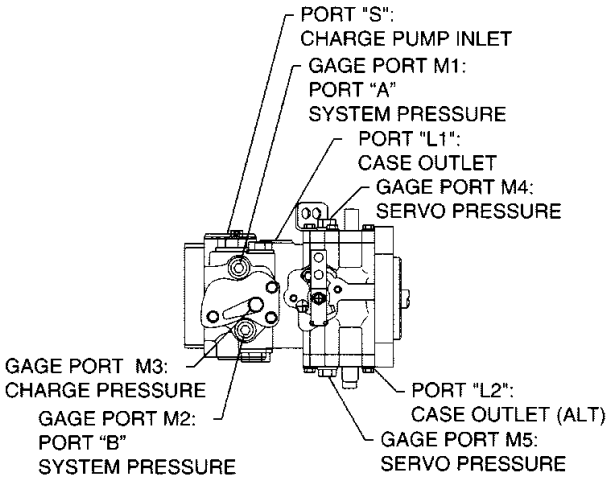
GAUGE INSTALLATION

It will be necessary to install a high pressure gauge into the system pressure gauge ports to check the setting of the high pressure relief valves.

Measuring the charge pump inlet vacuum will help locate restrictions in the inlet lines, filter, etc.

Case pressure readings can help locate restrictions in the return lines, oil cooler, and return filter.

Gauge Information		
M1	System Pressure Port A	10, 000 PSI or 600 Bar Gauge
		9/16-18 O-ring Fitting
M2	System Pressure Port B	10, 000 PSI or 600 Bar Gauge
		9/16-18 O-ring Fitting
M3	Charge Pressure	1000 PSI or 60 Bar Gauge
		9/16-18 O-ring Fitting or Tee into Charge Pressure Filter Outlet Line
L1 L2	Case Pressure	1000 PSI or 60 Bar Gauge
		1-1/16-12 O-ring Fitting
S	Charge Pump Inlet Vacuum	Vacuum Gauge
		Tee into Charge Pump Inlet Line
M4	Servo Pressure	1000 PSI or 60 Bar Gauge
		9/16-18 O-ring Fitting
M5	Servo Pressure	1000 PSI or 60 Bar Gauge
		9/16-18 O-ring Fitting



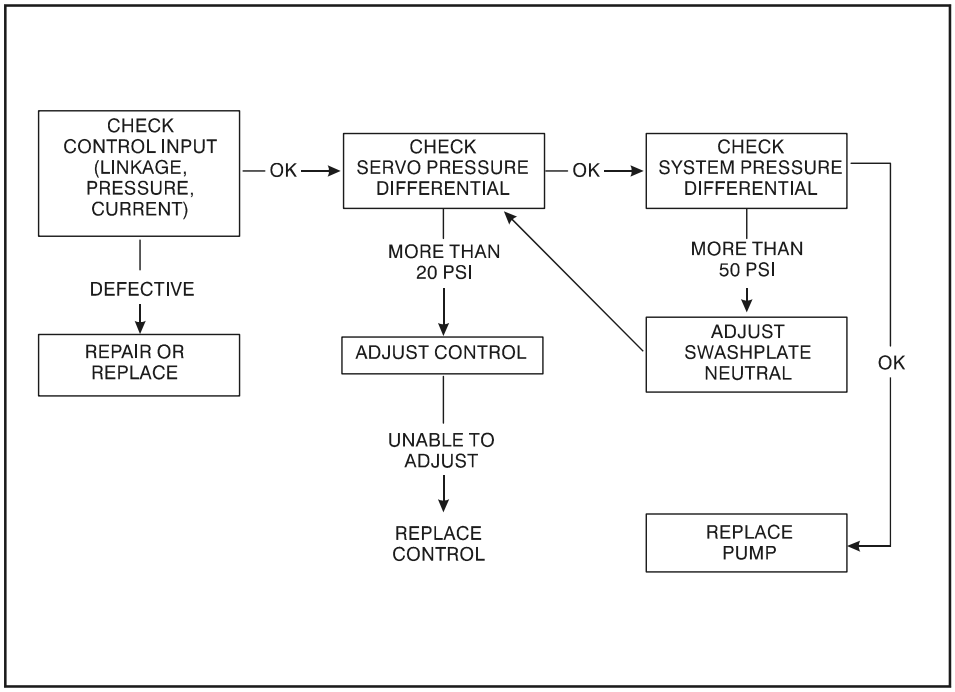


Figure 5-13. Troubleshooting - Neutral Difficult or Impossible to Find

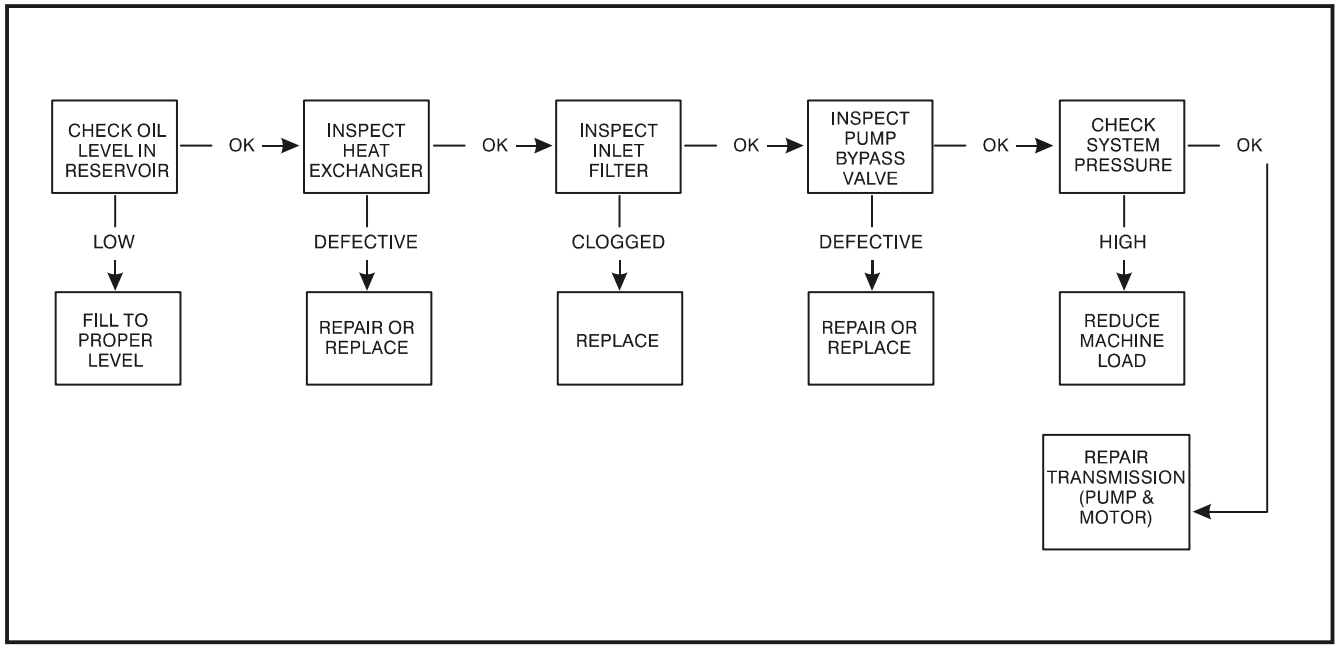


Figure 5-14. Troubleshooting - System Operating Hot

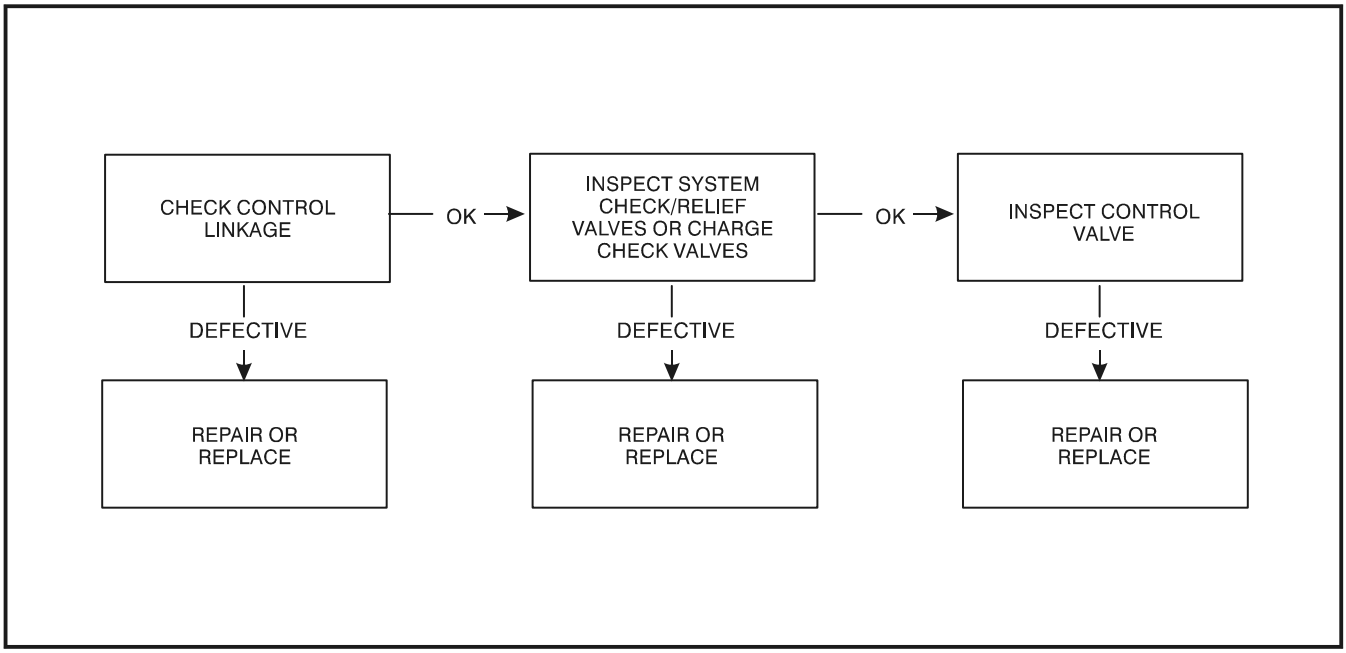


Figure 5-15. Troubleshooting - Transmission Operates in One Direction Only

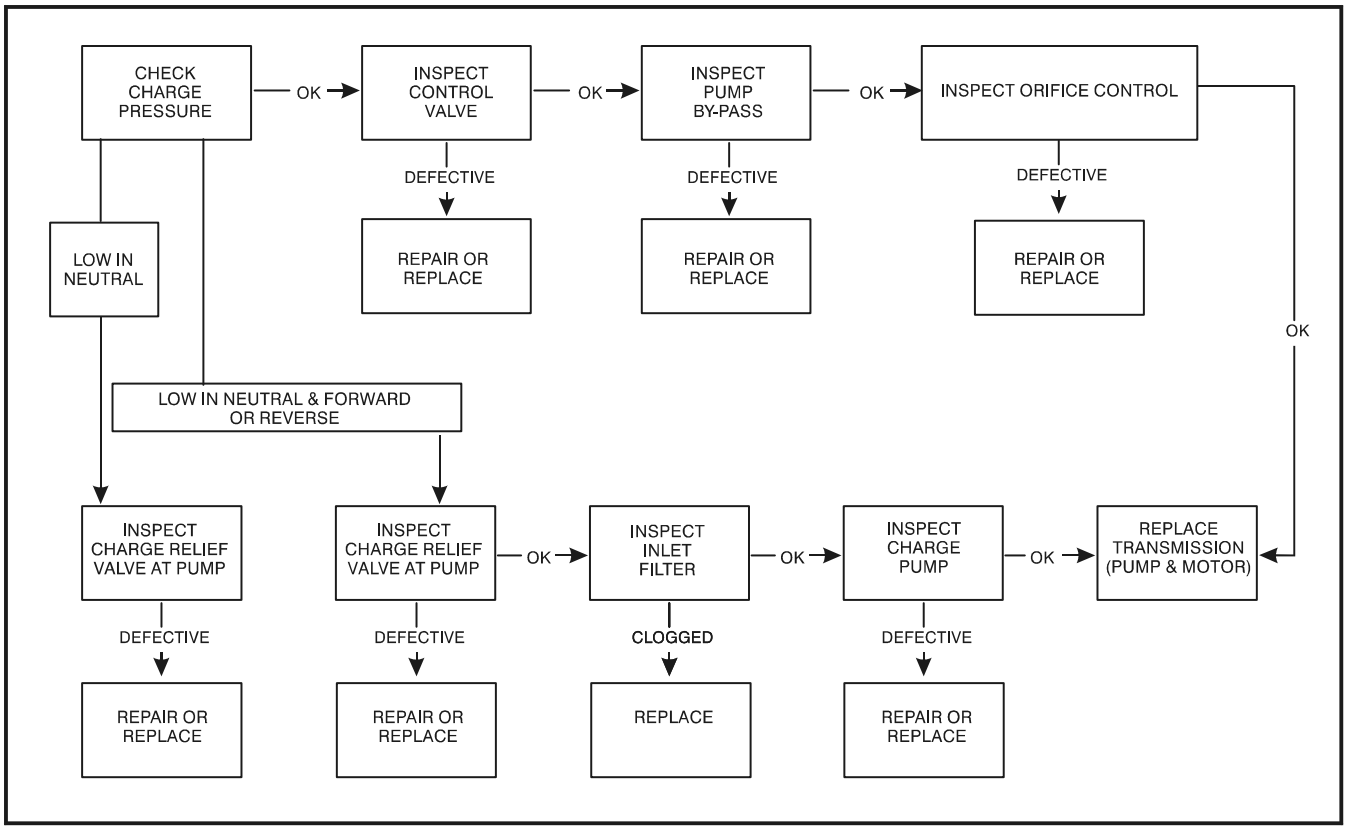


Figure 5-16. Troubleshooting - System Response is Sluggish

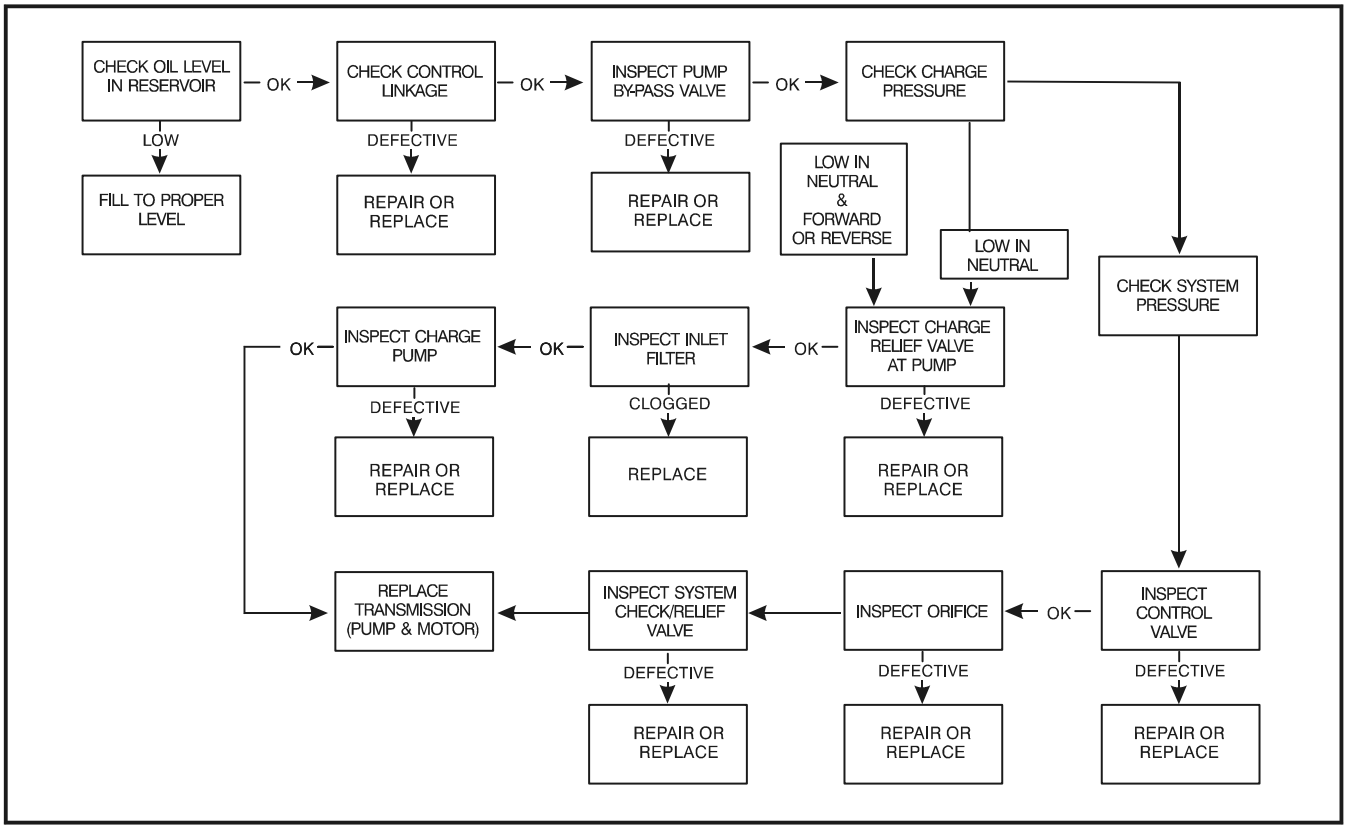
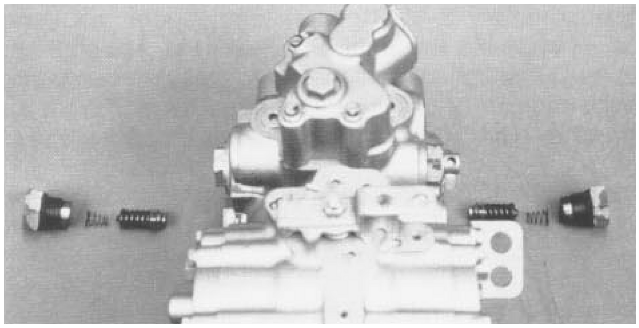


Figure 5-17. Troubleshooting - System Will Not Operate in Either Direction

Inspections and Adjustments

CHECK/HIGH PRESSURE RELIEF VALVES

The system check/relief valves have the dual purpose of providing make-up oil during by-directional rotation and providing protection from system over pressure. When the problem occurs in one direction only, interchange the check/relief valves to see if the problem changes to the other direction. If so, one check/relief valve cartridge is either malfunctioning or does not have the proper setting.



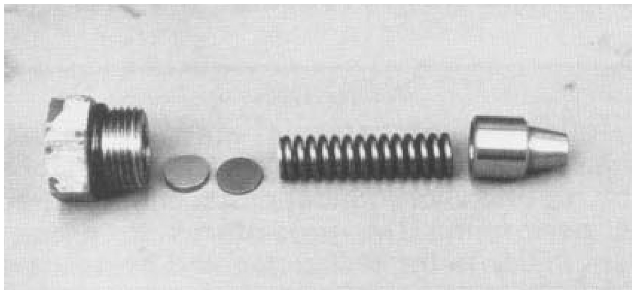
⚠ CAUTION

THE RELIEF VALVES ARE FACTORY SET AND SHOULD NOT BE TAMPERED WITH EXCEPT FOR REPLACING THE ENTIRE CARTRIDGE. DISASSEMBLY MAY CHANGE THE SETTING AND CAUSE ERRATIC UNIT OPERATION OR PREMATURE FAILURE.

PUMP CHARGE RELIEF VALVE

If charge pressure is low (less than 220 psi [15.2 Bar] above case pressure), the charge relief valve should be inspected. Inspect for foreign material holding the poppet open, and for scoring or wear on the poppet and seat in the housing.

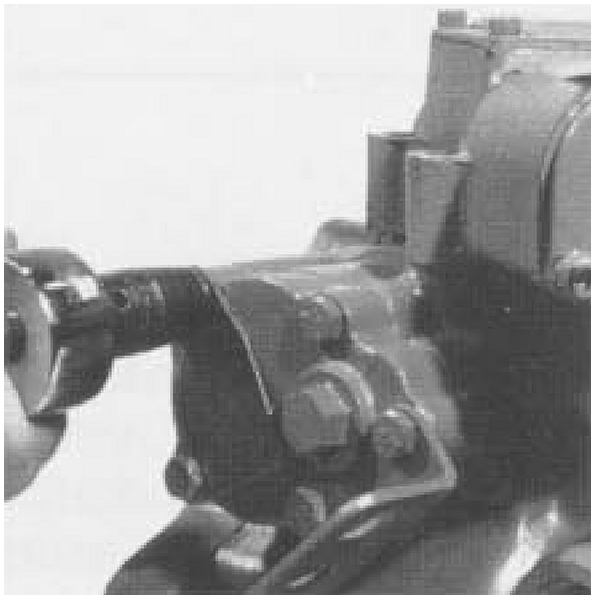
Adjustments of the charge pressure is accomplished by changing the shim thickness behind the spring.



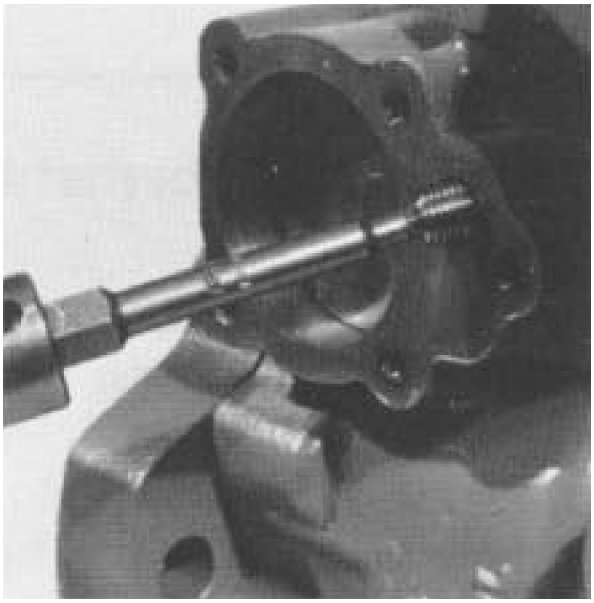
ELECTRICAL DISPLACEMENT CONTROL ORIFICES

NOTE: *The pump should have two control orifices located under the servo covers.*

1. With a 7/16" wrench, remove the five bolts from the servo cover opposite the neutral adjustment (cover without the adjustment screw).

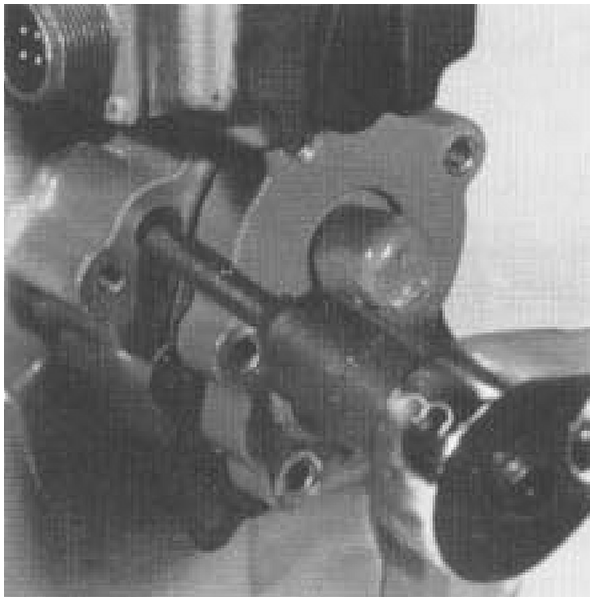


2. With a 7/32" internal wrench, remove and inspect the orifice.



3. Remove the bolts from the servo cover on the neutral adjustment side. Install a spacer or sprocket, approximately 0.75 in. (19 mm) long, under the servo cover opposite the neutral adjustment.

4. Re-install the bolts and tighten until the servo cover on the neutral adjustment side of the pump separates 0.125 in. (3 mm) from the housing. Turn the cover and remove and inspect the orifice.

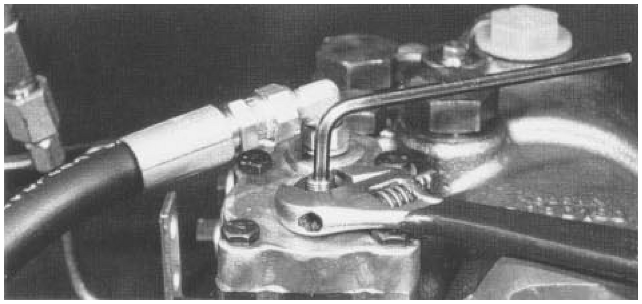


NOTE: *The Displacement Control may first have to be removed in order to rotate the servo cover.*

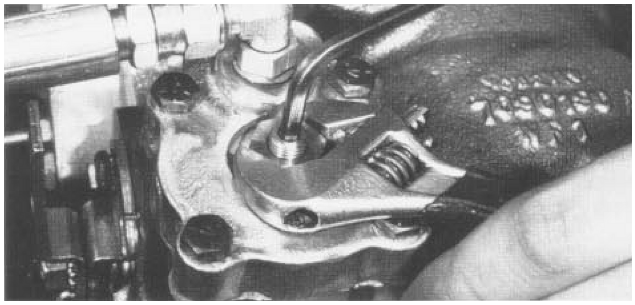
5. Remove spacer, re-install orifices, gaskets, and covers. Torque grade 5 bolts 8 to 11 ft.lbs. (10.8 to 14.9 Nm) and grade 8 bolts 11 to 13 ft.lbs. (14.9 to 17.8 Nm).

SWASHPLATE NEUTRAL ADJUSTMENT

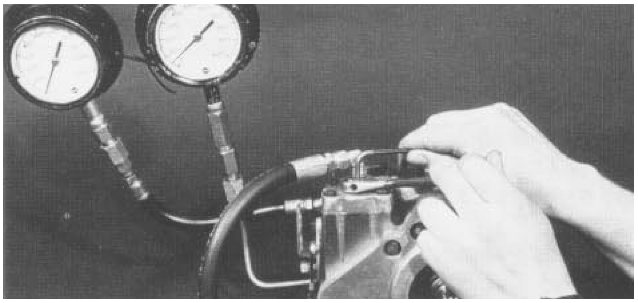
1. Using a low pressure line (500 psi [35 Bar] min.), cross port servo port F to servo port G. This removes the effects of any control pressure on the servo piston.



2. Install pressure gauges (10,000 psi [690 Bar]) in the system pressure gauge ports. Start the engine and slowly accelerate to normal operating RPM.
3. Remove the protective cap and loosen the servo lock nut while holding the servo adjustment screw in position.



4. Turn the servo adjustment screw until the two system pressure gauge readings are equal.
5. Turn the servo adjustment screw clockwise until one of the system pressures starts to increase.



6. Noting the amount of rotation, turn the servo adjustment screw counter-clockwise until the other system pressure starts to increase.
7. Turn the servo adjustment screw clockwise half the amount of rotation noted above.
8. While holding the servo adjustment screw from turning, torque the servo lock nut 13 to 18 ft.lbs. (17.6 to 24.4 Nm). Stop the engine, install a new protective cap, remove the servo cross-port line, and proceed to the appropriate control adjustment.

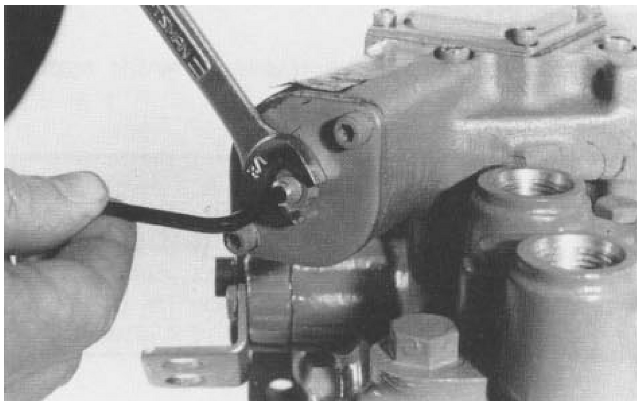
EDC NEUTRAL ADJUSTMENT

1. Remove the electrical connector at the EDC. Remove the servo cross port line (installed while making the swash plate neutral adjustment) and install a 0 to 300 PSI (0 to 21 BAR) gauge in each servo port.

⚠ WARNING

THE FOLLOWING PROCEDURE MAY REQUIRE THE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, WORK FUNCTION DISCONNECTED, ETC.) WHILE PERFORMING THE PROCEDURES IN ORDER TO PREVENT INJURY TO THE TECHNICIAN AND BYSTANDERS.

2. Start the engine and accelerate to normal operating RPM.
3. Loosen lock nut with 1/2” wrench and slowly rotate the neutral adjustment screw, with 5/32” internal hex wrench, until the pressure is equal on both servo gauges.



4. Slowly rotate the neutral adjustment screw until one of the servo gauges starts to increase in pressure.
5. Noting the amount of rotation, slowly rotate the neutral adjust screw in the opposite direction until the other servo gauge begins to increase in pressure.
6. Turn the neutral adjust screw back one - half the amount noted above. Hold the neutral adjust screw and torque the lock nut to 25 to 30 in.lbs. (2.8 to 3.4 NM).
7. Stop the engine. Connect the control input. Remove the servo pressure gauges. Return the machine to normal operating condition. Restart the engine and assure that the hydrostatic system is in neutral.

Minor Repair and Replacement

Minor repairs may be performed, following the procedures in this section.

Cleanliness is a primary means of assuring satisfactory transmission life, on either new or repaired units. Cleaning parts by using solvent wash and air drying is usually adequate. As with any precision equipment, all parts must be kept free of foreign materials and chemicals.

Protect all exposed sealing surfaces and open cavities from damage and foreign material.

It is recommended that all gaskets and O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly. All gasket sealing surfaces must be cleaned prior to installing new gaskets.

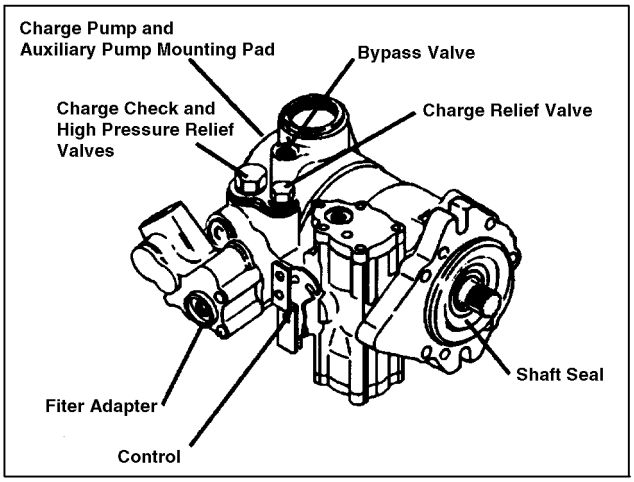


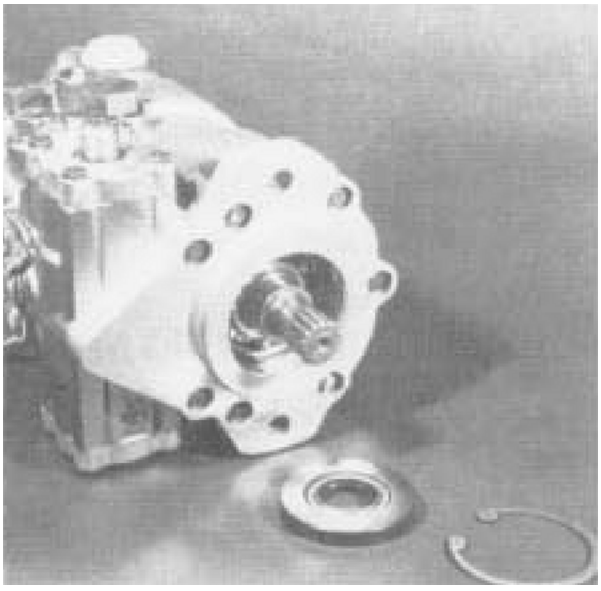
Figure 5-18. Variable Displacement Pump

SHAFT SEAL

Lip type shafts are used on Series 40 - M46 pumps and motors. These seals can be replaced without major disassembly of the unit. However, replacement of the shaft seal requires removal of the pump from the machine.

1. Remove the retaining ring from the housing.

2. Carefully remove the seal from the housing bore. The face of the seal may be punctured with a sharp instrument (such as a screw driver) to aid in prying the seal out, or a slide hammer type puller may be used to remove the seal. Care must be taken so as not to damage the housing bore or shaft. Once removed, the seal is not reusable.

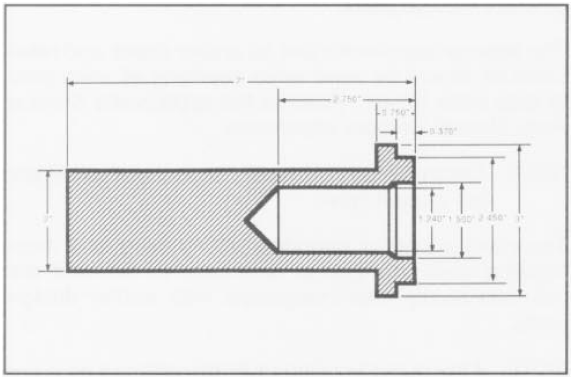


3. Prior to installing the new seal, inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.

4. Wrap the spline or key end of the shaft with thin plastic to prevent damage to the seal lip during installation. Lubricate the inside diameter of the new seal with petroleum jelly.

NOTE: *The outside diameter of the seal may be lightly coated with sealant (such as Loctite High Performance Sealant #59231) prior to installation. This will aid in preventing leaks caused by damage to the housing seal bore.*

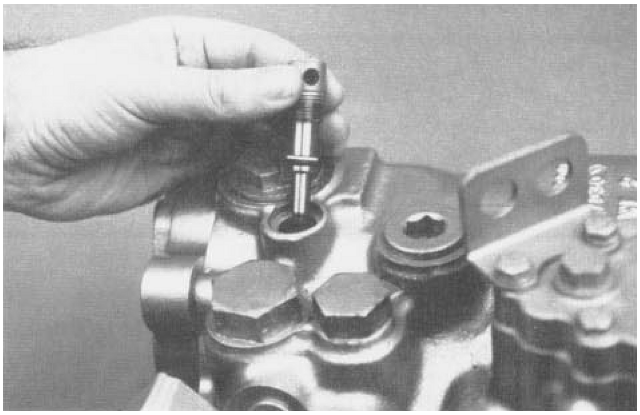
5. Slide the new seal over the shaft and press it into the housing bore. Be careful not to damage seal. A seal installer tool can be made to aid in installing the seal.



6. Reinstall the seal retaining ring.

BYPASS VALVE (PUMP)

1. Unscrew the bypass valve from the housing. Inspect the valve and mating seat for damage or foreign material. It is recommended that the O-ring and back - up ring be replaced.

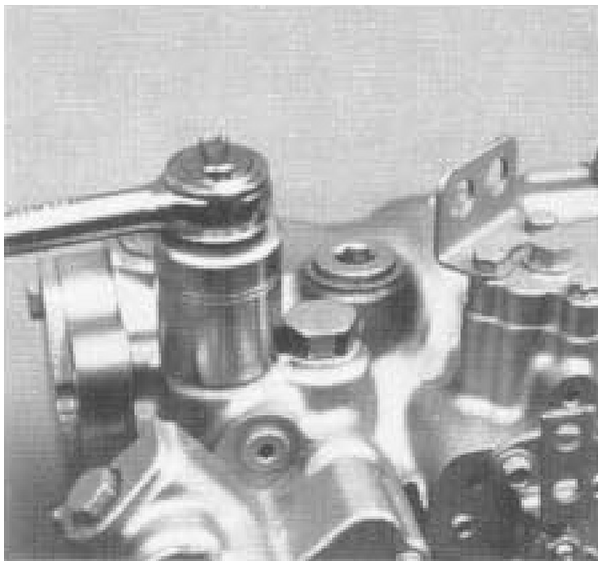


NOTE: *Bypass valves are available with integral bypass orifices for specific applications. Refer to the appropriate Service Parts Manual for more information.*

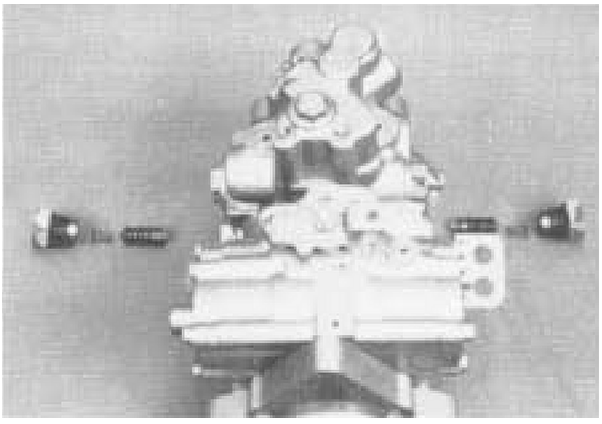
2. Reinstall the bypass valve into the housing. Torque to 7 to 10 ft. lbs. (9.5 - 13.6 Nm).

CHARGE CHECK AND HIGH PRESSURE RELIEF VALVES

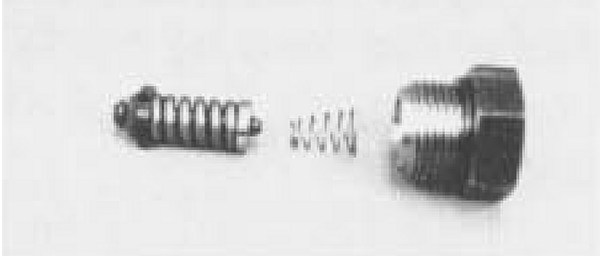
1. Remove the charge check and high pressure relief valve hex plug.



2. Remove the spring and check poppet or valve cartridge from the housing. Inspect the valve and mating seat in the housing for damage or foreign material. It will be necessary to replace the housing if the seat is damaged.



3. Several designs of charge check and high pressure relief valves have been used. Do not attempt to mix different vintage parts.



The appropriate check valve kit and/ or check and relief valve kit should be used. Refer to appropriate Service Parts Manual.

NOTE: *Always replace ball type charge check valves with the poppet type.*

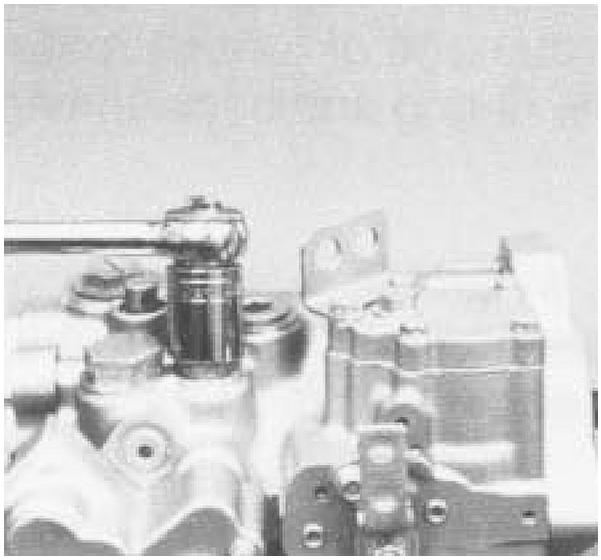
4. Reinstall the valve cartridge, spring, and plug (with O-ring) into the housing. Torque the plug to 30 to 70 ft. lbs. (41 to 95 Nm).

⚠ CAUTION

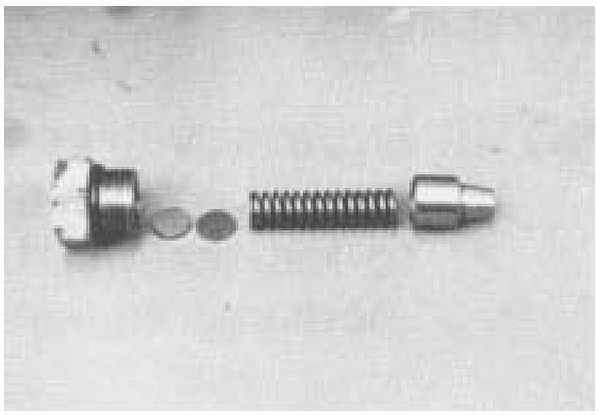
THE RELIEF VALVES ARE FACTORY SET AND SHOULD NOT BE TAMPERED WITH EXCEPT FOR REPLACING THE ENTIRE CARTRIDGE. DISASSEMBLY MAY CHANGE THE SETTING AND CAUSE ERRATIC UNIT OPERATION OR PREMATURE FAILURE.

CHARGE PRESSURE RELIEF VALVE

1. Remove charge relief valve hex plug.



2. Remove the spring and poppet from the housing. Do not alter the shims or interchange parts with another valve. Inspect the poppet and mating seat in the end cap for damage or foreign material.



3. Reinstall the poppet, spring, and plug (with shims and O-ring) into the housing. Torque the plug to 30 to 70 ft. lbs.(41 to 95 Nm).

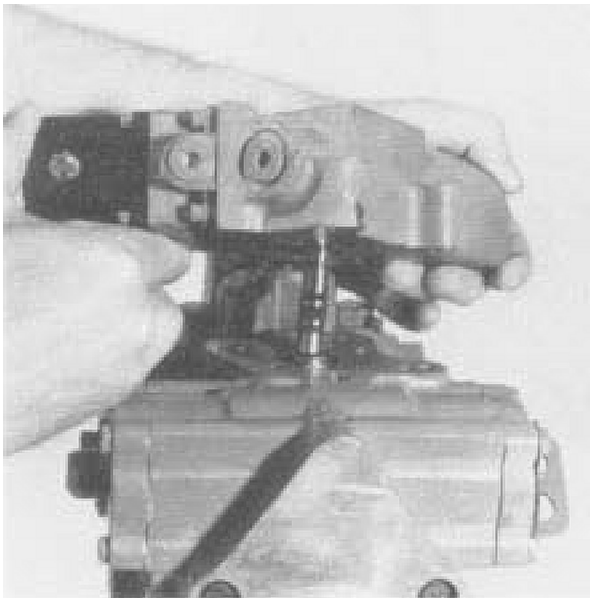
ELECTRICAL DISPLACEMENT CONTROLS (EDC)

⚠ CAUTION

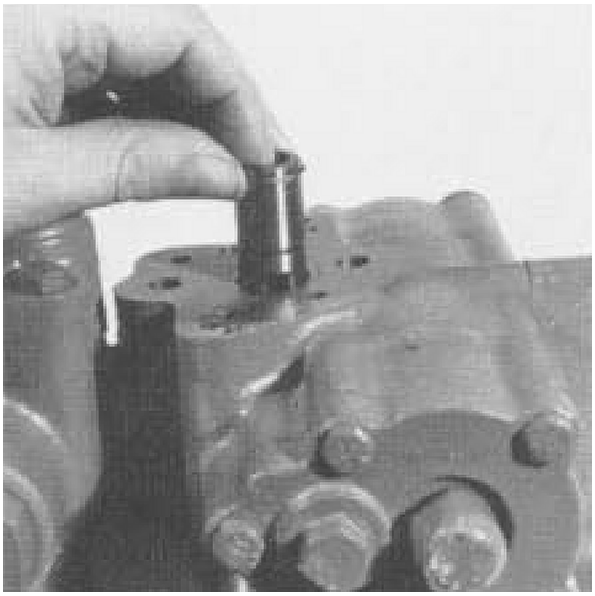
THE REMOVAL OF ANY PORTION OF THE CONTROL MECHANISM MAY RESULT IN LOSS OF NEUTRAL, WHICH WILL NECESSITATE READJUSTMENT.

1. Remove the four control mounting screws using an internal hex wrench (3/16”).

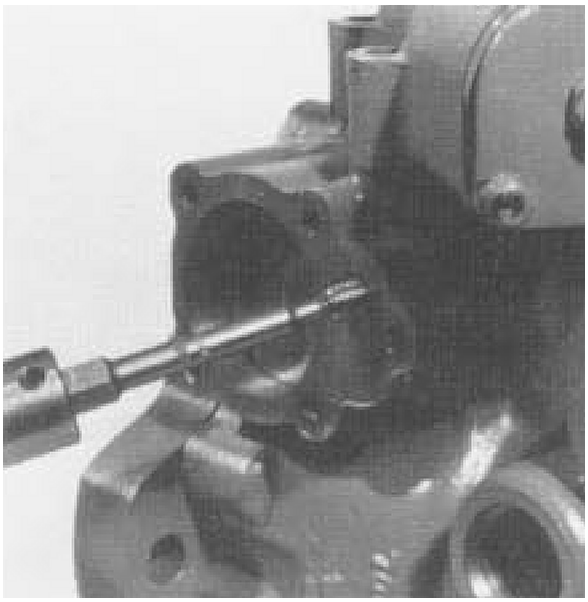
2. Carefully lift the control off the pump housing.



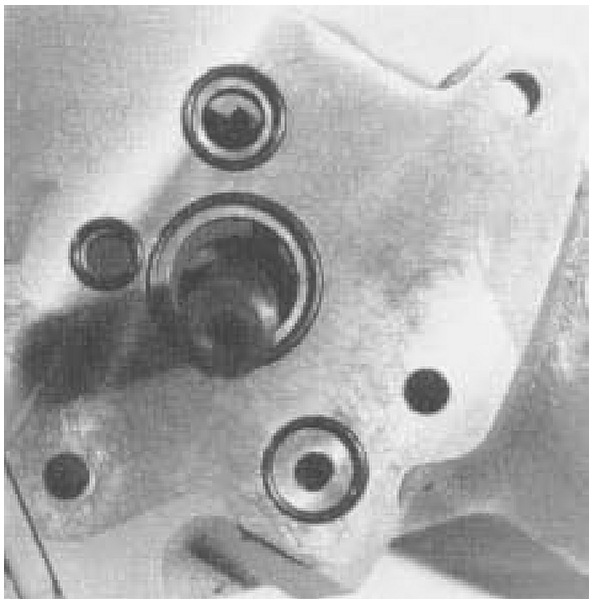
3. Remove the control sleeve from the pump.



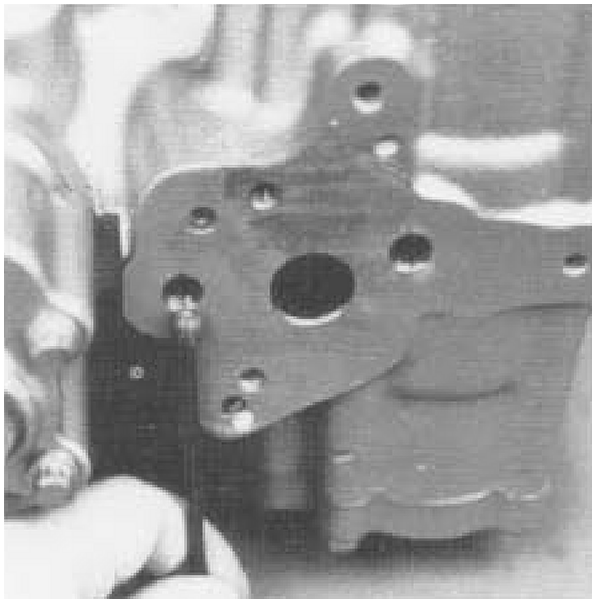
4. Remove the control inlet screen plug from the inlet passage next to the control sleeve bore, using an internal hex wrench (5/32”).
5. The control orifice plugs are located in threaded passages under the servo piston cover. Remove the servo piston cover and gasket, and remove the orifice plugs using an internal hex wrench (7/32”).



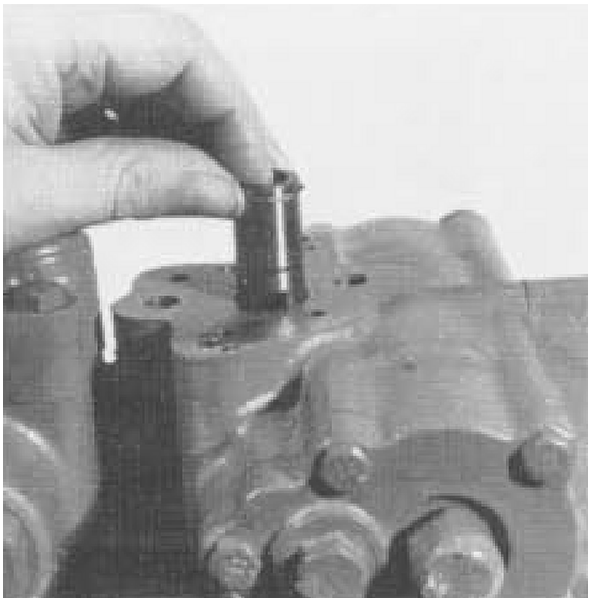
6. Replace the O-ring on the bottom of the control housing.Lightly lubricate all O-rings with clean petroleum jelly prior to assembly. The control spool and sleeve are a matched set and are not available separately.



7. Reinstall the control orifice plugs into their passages and replace the servo piston covers.
8. Install the control inlet screen plug and torque to 20 to 30 in.lbs. (2.2 to 3.4 Nm). Always install a screen plug (with a 0.156" (3.96 mm.) thru hole) when servicing earlier production pumps. Pumps prior to date c ode 86 - 14 use a plug with a thread that is different from later units. Refer to the Service Parts Manual for plug part numbers.



9. Align the control sleeve so its slot will engage the swash plate feedback pin (slot) positioned toward the pump cover) and insert the sleeve into the housing. Carefully align the control spool with the sleeve and install the control onto the pump housing. Install the four mounting screws and torque to 10 to 11 ft.lbs. (13 to 14 Nm).



10. Install the four cover screws and torque to 18 to 24 in. lbs. (2.0 to 2.7 Nm).
11. Readjust the neutral position of the control. Refer to the instructions in the Inspections and Adjustment.

5.7 PRESSURE SETTING PROCEDURES

⚠ IMPORTANT

COLD TEMPERATURES HAVE A SIGNIFICANT IMPACT ON PRESSURE READINGS. JLG INDUSTRIES, INC. RECOMMENDS OPERATING THE MACHINE UNTIL THE HYDRAULIC SYSTEM HAS WARMED TO NORMAL OPERATING TEMPERATURES PRIOR TO CHECKING PRESSURES. JLG ALSO RECOMMENDS USING A CALIBRATED GAUGE. PRESSURE READINGS ARE ACCEPTABLE IF WITHIN +/- 5% OF SPECIFIED PRESSURES.

Main Relief, Steer, Swing and Lift Down

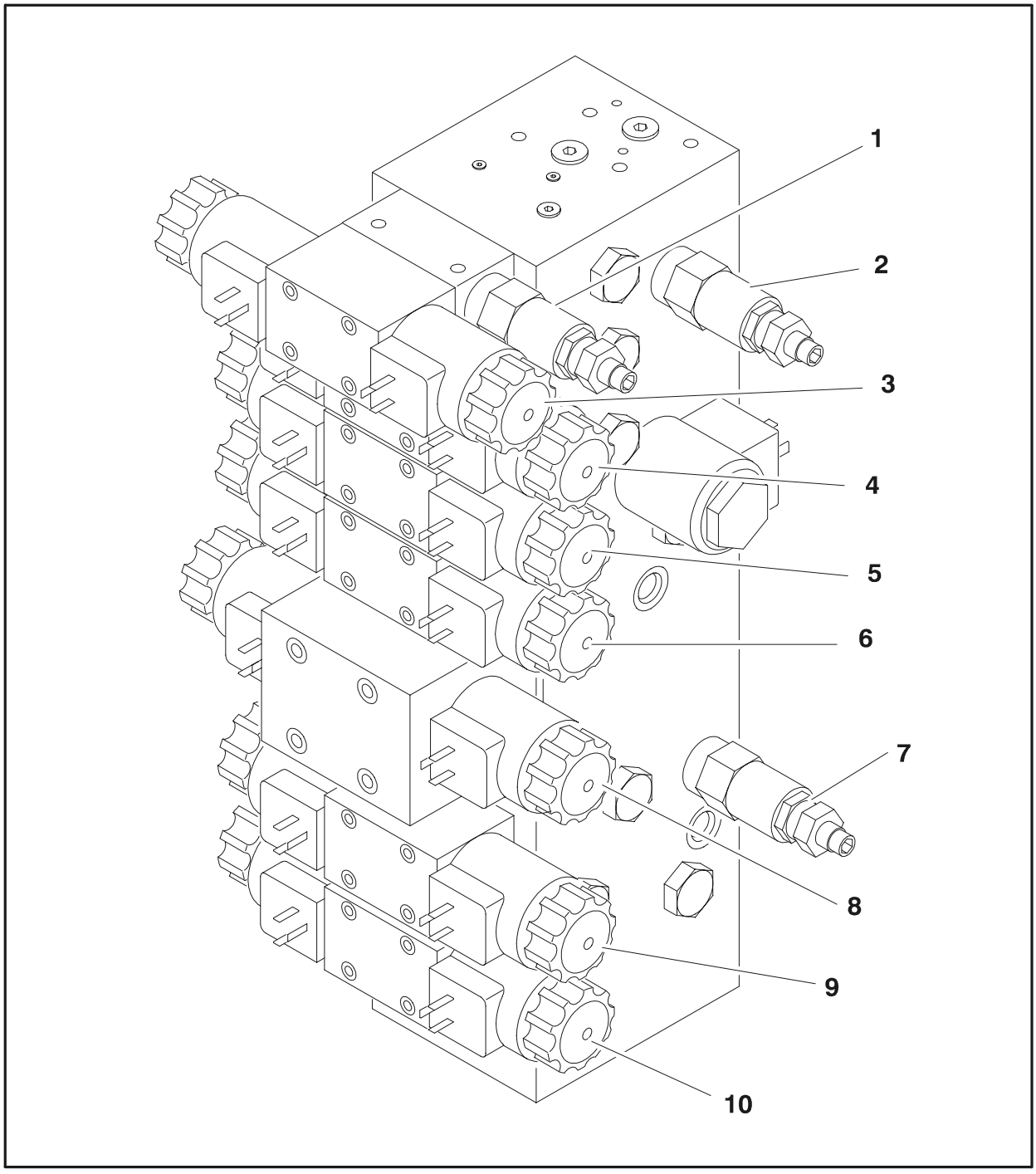
a. Install pressure gauge at quick disconnect on port MP on main valve.
b. With the aid of an assistant, activate telescope in.
c. While monitoring pressure gauge, adjust main relief to 3000 PSI (206.85 Bar).
d. With the aid of an assistant, activate steer left.
e. While monitoring pressure gauge, adjust steer left relief to 1800 PSI (124.1 Bar).
f. With the aid of an assistant, activate steer right.
g. While monitoring pressure gauge, adjust steer right relief to 1800 PSI (124.1 Bar).
h. With the aid of an assistant, activate swing left or right.
i. While monitoring pressure gauge, adjust swing relief to 1700 PSI (117.2 Bar).
j. With the aid of an assistant, activate lift down.
k. While monitoring pressure gauge, adjust lift down relief to 1500 PSI (103.4 Bar).

Platform Level

a. Install pressure gauge at quick disconnect on port M3 on main valve.
b. With the aid of an assistant, activate platform level forward.
c. While monitoring pressure gauge, adjust platform level relief to 2800 PSI (193.06 Bar).
d. Install pressure gauge at quick disconnect on port M4 on main valve.
e. With the aid of an assistant, activate platform level backward.
f. While monitoring pressure gauge, adjust platform level relief to 1800 PSI (124.11 Bar).

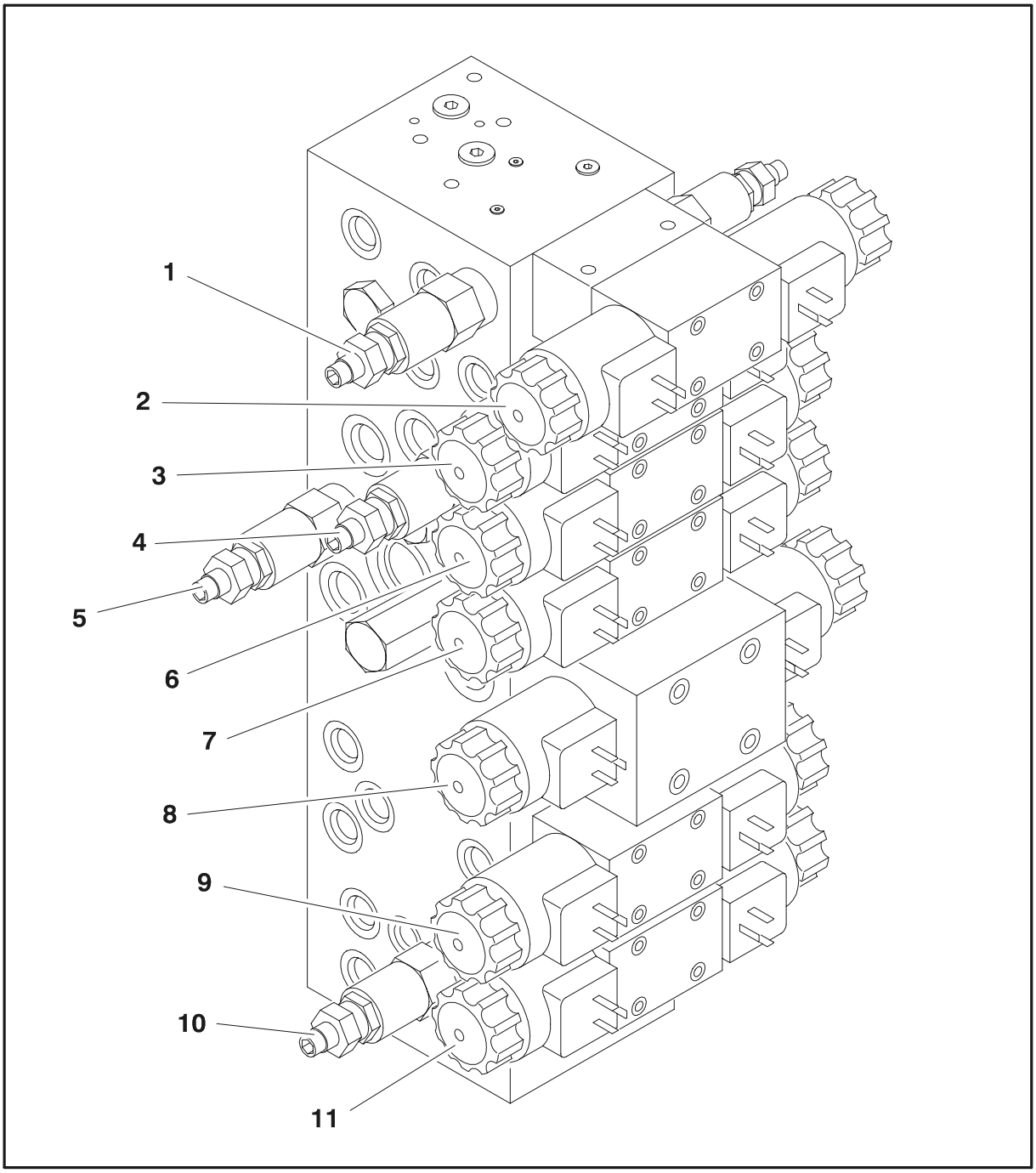
4 Wheel Steer (If Equipped)

a. At the platform console using the steer select switch activate “2 wheel steer”.
b. Install a pressure gauge in port G on main control valve.
c. With the aid of an assistant, activate steer left and right, adjust front steer relief valve to 2500 PSI (172.4 Bar). This pressure only affects the front axle.
d. At the platform console using the steer select switch activate “crab” or “coordinated” steer.
e. At the main control valve block disconnect the wire din connectors on the front steer valve. When steer is activated only the rear steer will work.
f. Install a pressure gauge in port G on main control valve.
g. With the aid of an assistant, activate steer left and right, adjust rear steer relief valve to 2500 PSI (172.4 Bar). Reading at the valve bank 2500 PSI (172.4 Bar) will give you 2000PSI (137.9 Bar) at the cylinders.
h. Re-connect the front steer din connectors at the valve bank.



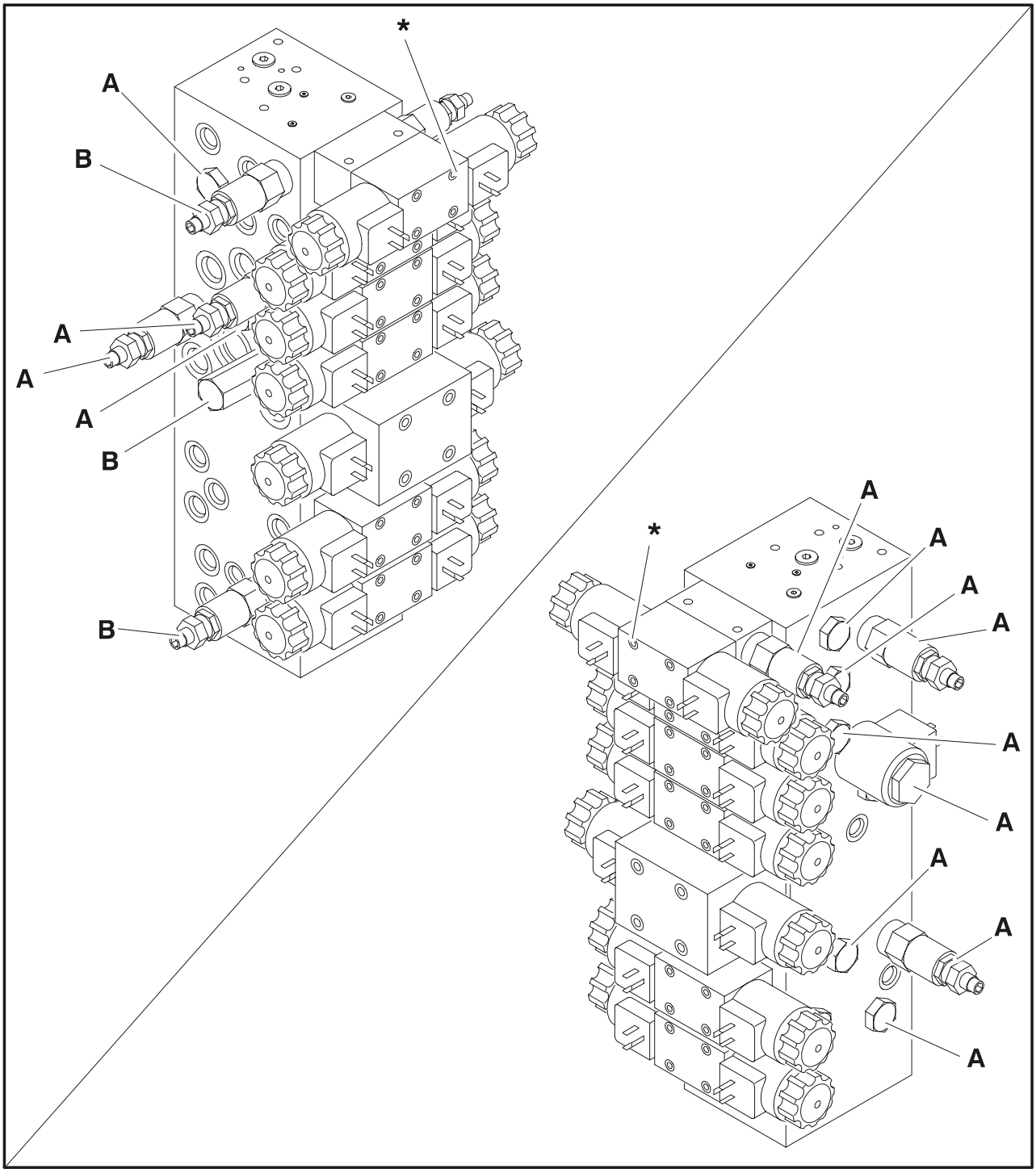
1. Front Steer Right Relief
2. Swing Left & Right
3. Front Steering Right
4. Swing Right
5. Lift Down
6. Steer Dump
7. Platform Level Relief Up
8. Tele Out
9. Platform Rotate Right
10. Platform Level Down

Figure 5-19. Main Control Valve - Sheet 1 of 2



1. Front Steer Left Relief
2. Front Steering Left
3. Swing Left
4. Upper Lift Down Relief
5. Main Relief
6. Lift Up
7. Flow Control
8. Tele In
9. Platform Rotate Left
10. Platform Level Down Relief
11. Platform Level Up

Figure 5-20. Main Control Valve - Sheet 2 of 2



A. 18-20 ft.lbs. (24.5-27.2 Nm)

B. 25-27 ft.lbs. (34-36.7 Nm)

* Torque Valve Bolts to 60 in. lbs. (7 Nm)

Figure 5-21. Main Control Valve Torque Values

5.8 DIRECTIONAL CONTROL VALVE

When removing the directional control valves from the main valve block, it is important to observe the tag on the face of the valve, as the new valve must be installed with the tag facing the same way on the valve that was removed. The bolt pattern on the directional valve is not symmetrical, so if the bolts seem difficult to turn when installing, it would indicate the valve is upside down, and forcing the bolts would result in cross-threading. Check the tag and, if necessary, rotate the directional control valve 180 degrees and reinstall the bolts.

5.9 HYDRAULIC PUMP W/HAYES PUMP DRIVE COUPLING LUBRICATION

Any time pump or pump drive coupling is removed coat, pump and drive coupling splines with Lithium Soap Base Grease (TEXACO CODE 1912 OR EQUIVALENT) coupling is greased prior to assembly.

5.10 HYDRAULIC COMPONENT START-UP PROCEDURES AND RECOMMENDATIONS

From a hydrostatic component standpoint, the goal at system start up is to put into functional operation, the hydrostatic system in such a way as to preserve the designed life span of the system. The following start-up procedure should be adhered to whenever a new pump or motor is initially installed into a machine, or a system is restarted after either a pump or motor has been removed and/or replaced.

⚠ WARNING

THE FOLLOWING PROCEDURE MAY REQUIRE THE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, WORK FUNCTIONS DISCONNECTED, ETC.) WHILE PERFORMING THE PROCEDURE IN ORDER TO PREVENT INJURY. TAKE NECESSARY SAFETY PRECAUTIONS BEFORE MOVING THE VEHICLE/MACHINE.

Prior to installing the pump and/or motor, inspect the unit(s) for damage that may have been incurred during shipping and handling. Make certain that all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid. This fluid should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement.

NOTE: *If a pump or motor is being replaced due to internal damage, the remaining units (pump or motors) need to be inspected for damage and contamination, and the entire hydraulic system will need to be flushed and the fluid replaced. Failure to do so may cause considerable damage to the entire system.*

The inlet line leading from the reservoir to the pump must be filled prior to start-up. Check the inlet line for property tightened fittings and make sure it is free of restrictions and air leaks.

NOTE: *In most cases, the reservoir is above the pump inlet so that the pressure head created by the higher oil level helps to keep the inlet pressures within an acceptable range and prevent high vacuum levels. However, due to hose routing or low reservoir locations, there may be air trapped within this line. It is important to assure that the air is bled from this line. This can be accomplished by loosening the hose at the fitting closest the pump. When oil begins to flow, the line is full, the air has been purged, and the fitting can be retightened to its specified torque. If the tank needs to be pressurized in order to start the flow of oil, a vacuum reading should be taken at the inlet of the pump during operation in order to verify that the pump is not being asked to draw an inlet vacuum higher than it is capable of.*

Be certain to fill the pump and/or motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the upper case drain port.

NOTE: *It is highly recommended to use the highest possible case drain port, this ensures that the housing contains as much oil as possible and offers the greatest amount of lubrication to the internal components.*

NOTE: *In initial start-up conditions, it may be convenient to fill the housing, just prior to installing the case drain line. Component, (especially motor), location may be such that access to the case drain port after installation is not realistic.*

NOTE: *Make certain that the oil being used to fill the component housing is as clean as possible, and store the fill container in such a way as to prevent it from becoming contaminated.*

Install a 60 bar (or 1000 psi) pressure gauge in the charge pressure gauge port in order to monitor the charge pressure during start-up.

It is recommended that the external control input signal, (electrical connections for EDC), be disconnected at the pump control until after initial start-up. This will ensure that the pump remains in its neutral position.

⚠ WARNING

DO NOT START THE ENGINE UNLESS PUMP IS IN THE NEUTRAL POSITION (0 DEGREES SWASHPLATE ANGLE). TAKE PRECAUTIONS TO PREVENT MACHINE MOVEMENT IN CASE PUMP IS ACTUATED DURING INITIAL START-UP.

"Jog" or slowly rotate the engine until charge pressure starts to rise. Start the engine and run at the lowest possible RPM until charge pressure has been established. Excess air should be bled from the system lines as close to the motors as possible.

NOTE: *With the engine on low idle, "crack", (loosen-don't remove), the system lines at the motor(s). Continue to run the engine at low idle and tighten the system lines as soon as oil is observed to leak from them. When oil is observed to "leak" at the motor the line is full, the air has been purged, and the system hoses should be retightened to their specified torque.*

Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be as indicated in the pump model code. If charge pressure is inadequate, shut down and determine the cause for improper pressure.

⚠ WARNING

INADEQUATE CHARGE PRESSURE WILL AFFECT THE OPERATOR' S ABILITY TO CONTROL THE MACHINE.

Shut down the engine and connect the external control input signal. Also reconnect the machine function(s), if disconnected earlier. Start the engine, checking to be certain the pump remains in neutral. With the engine at normal operating RPM, slowly check for forward and reverse machine operation.

Charge pressure may slightly decrease during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five minutes.

Shut down engine, remove gauges, and plug ports. Check reservoir level and add filtered fluid if needed.

The machine is now ready for operation.

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SECTION 6. JLG CONTROL SYSTEM (ADE)

This section is applicable to machines from S/N 60188 to Present.

6.1 INTRODUCTION

⚠ IMPORTANT

WHEN INSTALLING A NEW GROUND MODULE CONTROLLER ON THE MACHINE, IT WILL BE NECESSARY TO PROGRAM THE CONTROLLER FOR THE PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS.

⚠ IMPORTANT

IT IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES, INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5 CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

The JLG designed Control System is a 12 volt based motor control unit installed on the boom lift.

The JLG Control System has reduced the need for exposed terminal strips, diodes and trimpots and provides simplicity in viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep, min speed, and max.-speed for all boom, drive, and steering functions.

The upper lift, swing, and drive are controlled by individual joysticks, with steering being controlled by a rocker switch built into the top the drive joystick. To activate Drive, Lift, and Swing simply pull up on the slide lock location on the joystick and move the handle into the direction desired.

The control system will control the voltage output to the valves and pump, as programmed for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed into the control system.

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed utilizing a custom designed, hand held analyzer (Analyzer, JLG part no. 1600244 & Cable, JLG part no. 1600633) which will display two lines of information at a time, by scrolling through the program.

NOTE: *Each module has a label with the JLG part number and a serial number which contains a date code.*

The following instructions are for using the hand held analyzer.

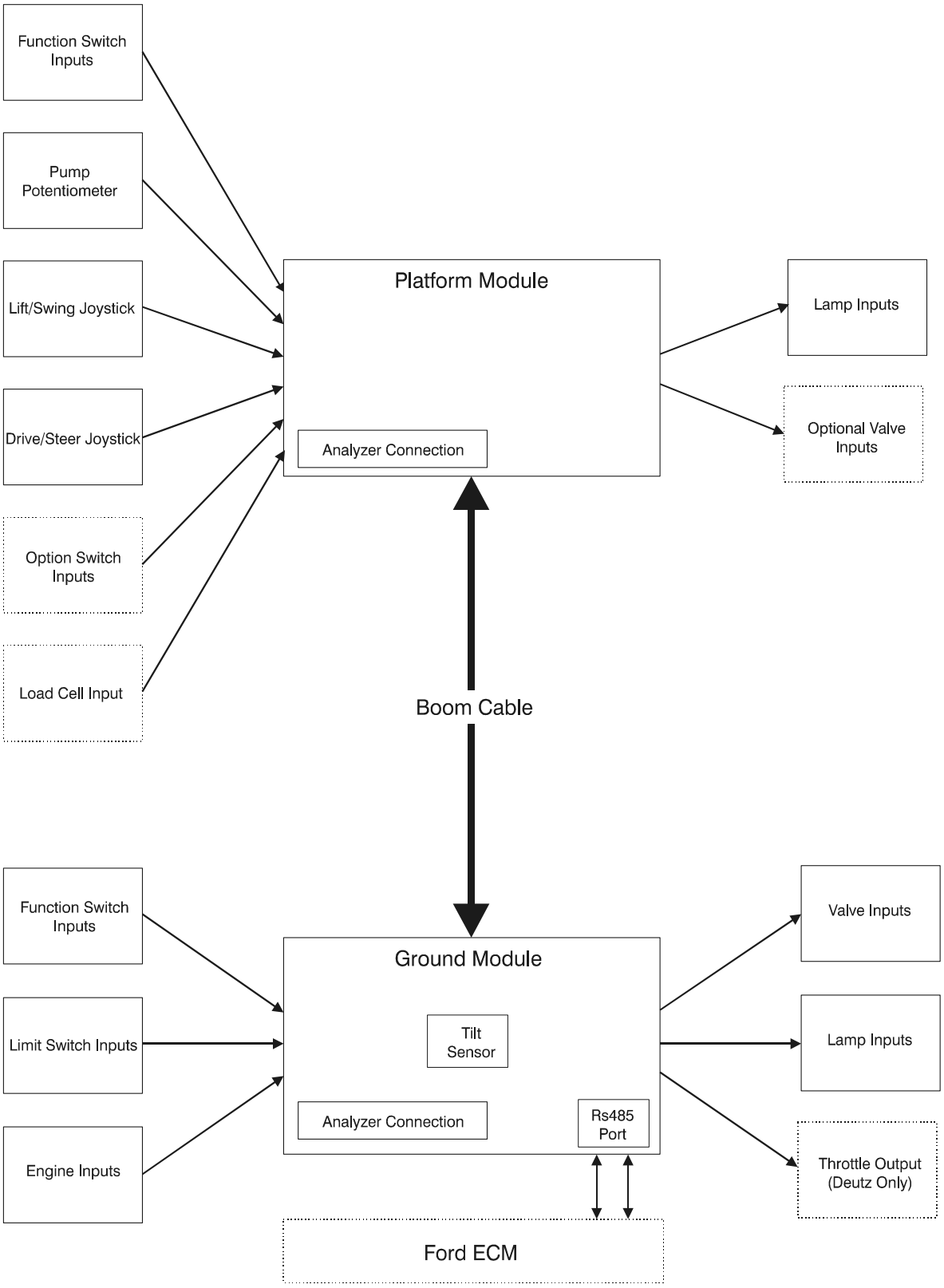


Figure 6-1. EPBCS Block Diagram

6.2 TO CONNECT THE JLG CONTROL SYSTEM ANALYZER

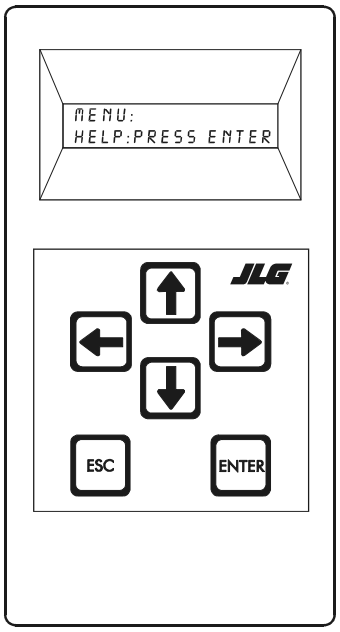
1. Connect the four pin end of the cable supplied with the analyzer, to the controller module located in the platform box or at the controller module in the ground control box and connect the remaining end of the cable to the analyzer.

NOTE: *The cable has a four pin connector at each end of the cable; the cable cannot be connected backwards.*

2. Power up the Control System by turning the lower key to the platform or ground position and pulling both emergency stop buttons on.

6.3 USING THE ANALYZER

With the machine power on and the analyzer connected properly, the analyzer will display the following:



HELP:
PRESS ENTER

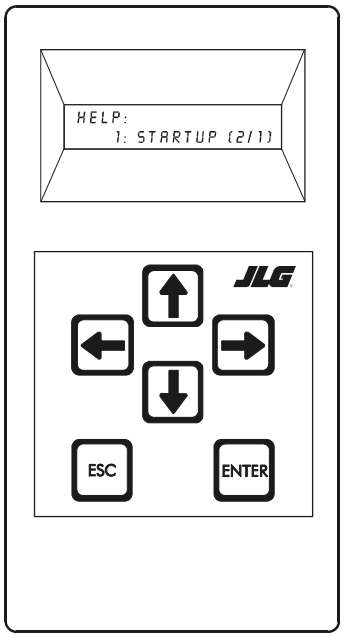
At this point, using the **RIGHT** and **LEFT** arrow keys, you can move between the top level menu items. To select a displayed menu item, press **ENTER**. To cancel a selected menu item, press ESC.; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

HELP
DIAGNOSTICS
SYSTEM TEST
ACCESS LEVEL
PERSONALITIES
MACHINE SETUP
CALIBRATIONS (view only)

If you press **ENTER**, at the **HELP: PRESS ENTER** display, and a fault is present, the analyzer display will scroll the fault across the screen. If there was no fault detected, the display will read: **HELP: EVERYTHING OK.** If powered up at the ground station, the display will read: **GROUND OK.**

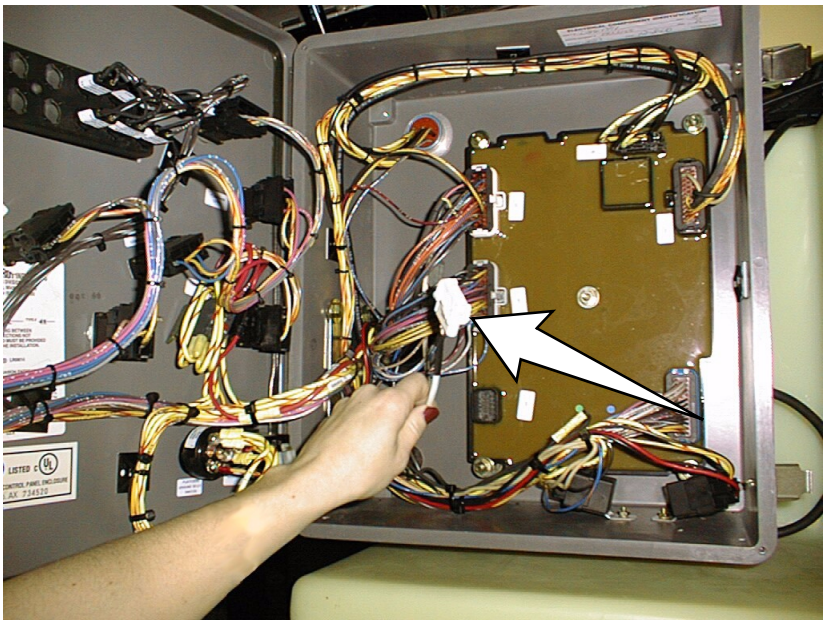
If **ENTER** is pressed again, the display moves to the following display:



LOGGED HELP
1: POWER CYCLE (0/0)

At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the beginning, press **ESC.** two times. **POWER CYCLE (0/0)** indicates a power up.

PLATFORM CONNECTION



GROUND CONTROL CONNECTION

Figure 6-2. Analyzer Connecting Points

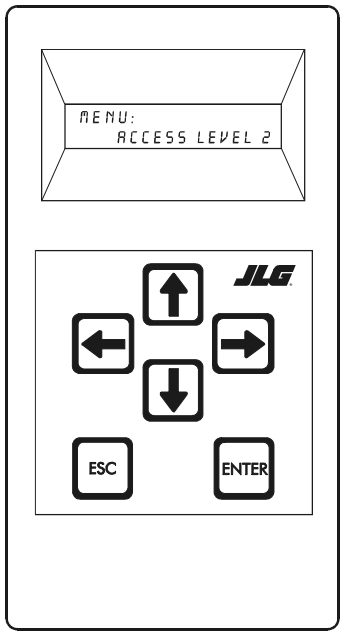
When a top level menu is selected, a new set of menu items may be offered: for example:

DRIVE
BOOM
SYSTEM
DATALOG
VERSIONS

Pressing **ENTER** with any of the above displayed menus, will display additional sub-menus within the selected menu. In some cases, such as **DRIVE**, the next level is the parameter or information to be changed. Refer to the flow chart for what menus are available within the top level menus. You may only view the personality settings for selected menus while in access level 2. Remember, you may always cancel a selected menu item by pressing the **ESC.** key.

6.4 CHANGING THE ACCESS LEVEL OF THE HAND HELD ANALYZER

When the analyzer is first connected, you will be in access level 2 which enables you to only view most settings which cannot be changed until you enter a password to advance to a lower level. This ensures that a setting cannot be accidentally altered. To change the access level, the correct password must be entered. To enter the password, scroll to the **ACCESS LEVEL** menu. For example:



MENU:
ACCESS LEVEL 2

Press **ENTER** to select the **ACCESS LEVEL** menu.

Using the **UP** or **DOWN** arrow keys, enter the first digit of the password, 3.

Then using the **RIGHT** arrow key, position the cursor to the right one space to enter the second digit of the password.

Use the **UP** or **DOWN** arrow key to enter the second digit of the password which is 33271.

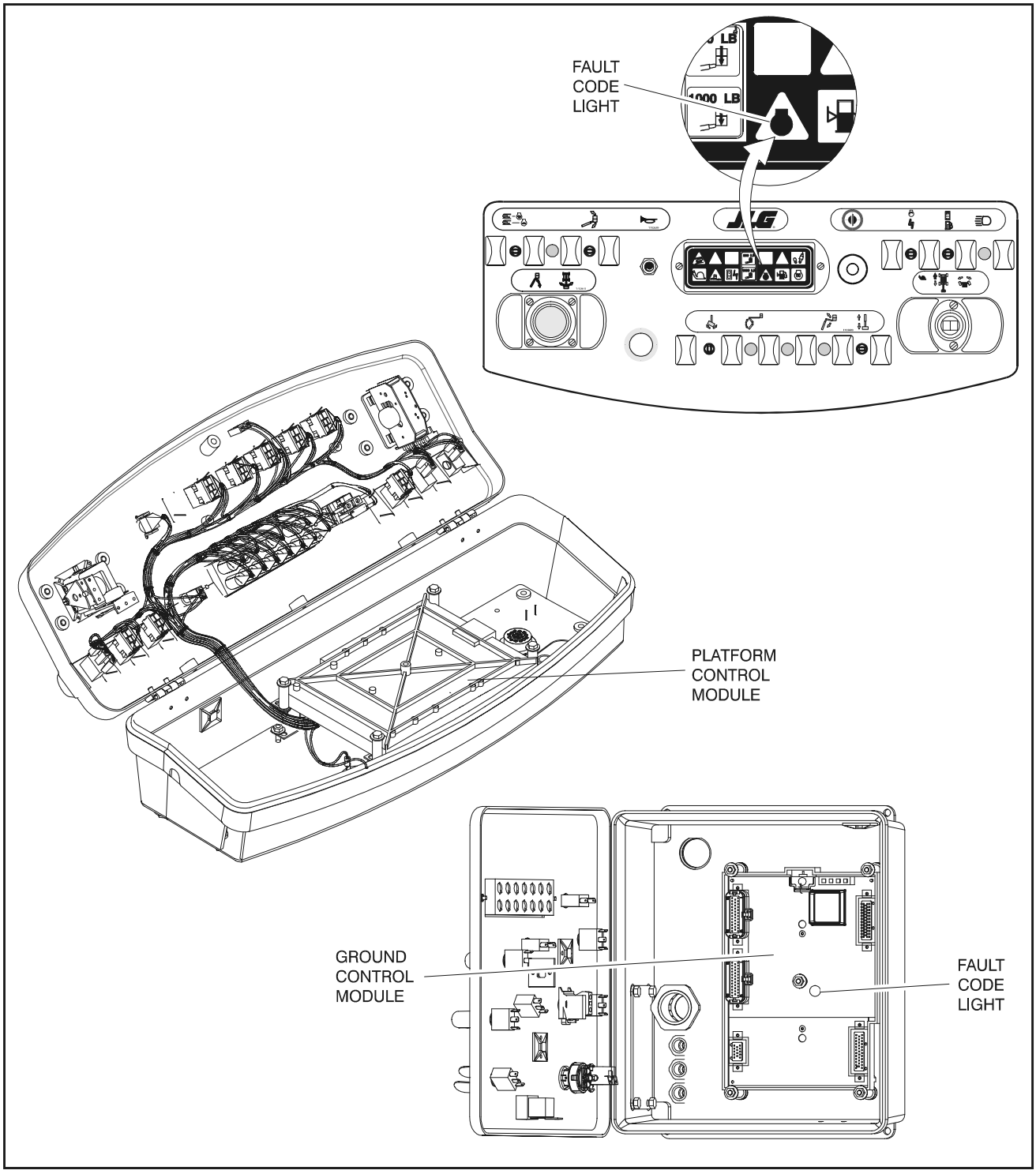
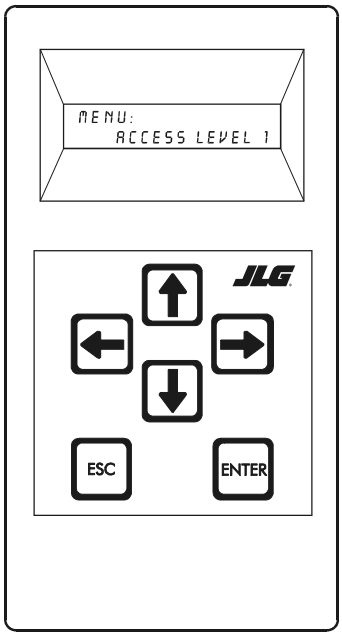


Figure 6-3. Control Module and Fault Code Indicator Location

Once the correct password is displayed, press **ENTER**. The access level should display the following, if the password was entered correctly:

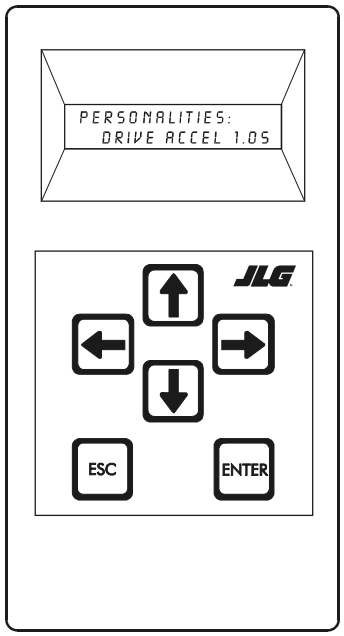


MENU:
ACCESS LEVEL 1

Repeat the above steps if the correct access level is not displayed or you can not adjust the personality settings.

6.5 ADJUSTING PARAMETERS USING THE HAND HELD ANALYZER

Once you have gained access to level 1, and a personality item is selected, press the UP or DOWN arrow keys to adjust its value, for example:

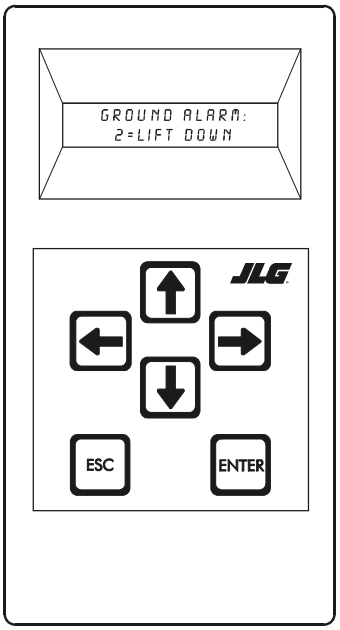


PERSONALITIES:
DRIVE ACCEL 1.0s

There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP** arrow is pressed when at the maximum value nor will the value decrease if the **DOWN** arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and won arrows, check the access level to ensure you are at access level 1.

6.6 MACHINE SETUP

When a machine digit item is selected, press the UP or DOWN arrow keys to adjust its value, for example:



GROUND ALARM:
2 = LIFT DOWN

The effect of the machine digit value is displayed along with its value. The above display would be selected if the machine was equipped with a ground alarm and you wanted it to sound when lifting down. There are certain settings allowed to install optional features or select the machine model.

When selection the machine model to match the size of the machine, the personality settings will all default to the factory recommended setting.

NOTE: *Refer to Table 6-1, Personality Ranges/Defaults, and in this Service Manual for the recommended factory settings.*

NOTE: *Password 33271 will give you access to level 1, which will permit you to change all machine personality settings.*

There is a setting that JLG strongly recommends that you do not change. This setting is so noted below:

ELEVATION CUTBACK

⚠ WARNING

CHANGING THIS SETTING MAY ADVERSELY AFFECT THE PERFORMANCE OF YOUR MACHINE.

⚠ IMPORTANT

ITS IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

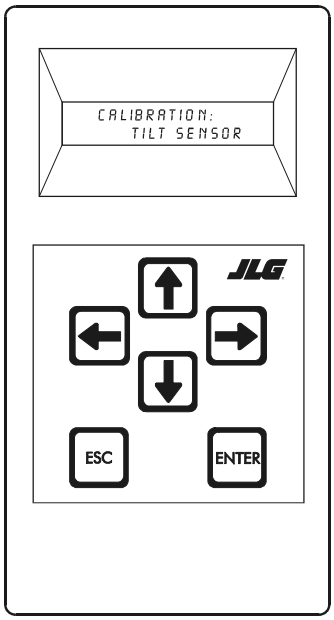
6.7 LEVEL VEHICLE DESCRIPTION

⚠ IMPORTANT

A NEW TILT MODULE WILL ACT AS IF IT IS TILTED ALL OF THE TIME UNTIL THE FOLLOWING PROCEDURE IS PERFORMED.

⚠ WARNING

DO NOT CALIBRATE THE LEVEL SENSOR EXCEPT ON A LEVEL SURFACE.



Place machine in stowed position with the boom between the rear wheels.

To level machine chose:

CALIBRATION:
TILT SENSOR

Press ENTER.

When prompted, swing machine 180°

Press ENTER.

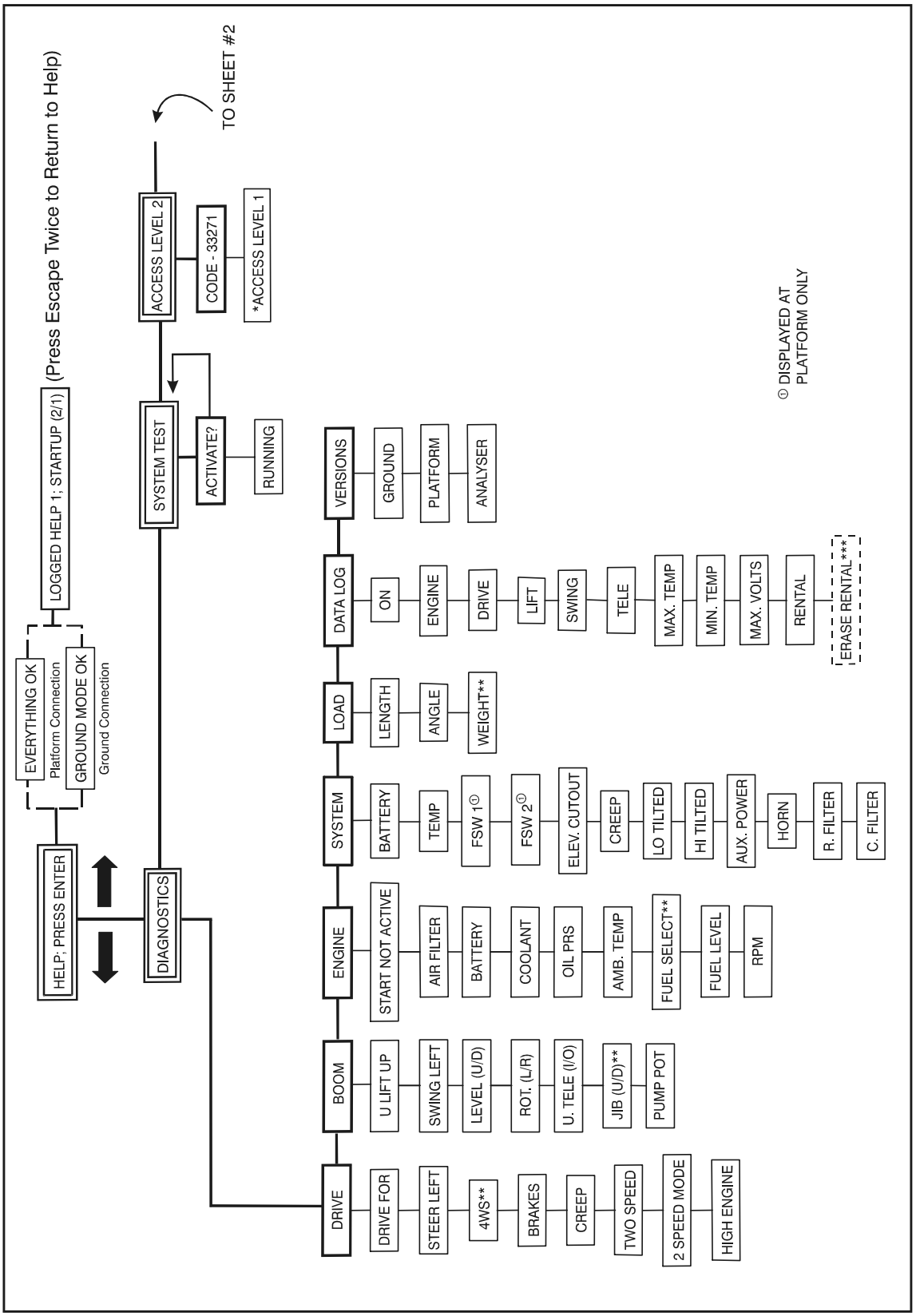


Figure 6-4. Analyzer Flow Chart - Sheet 1 of 3

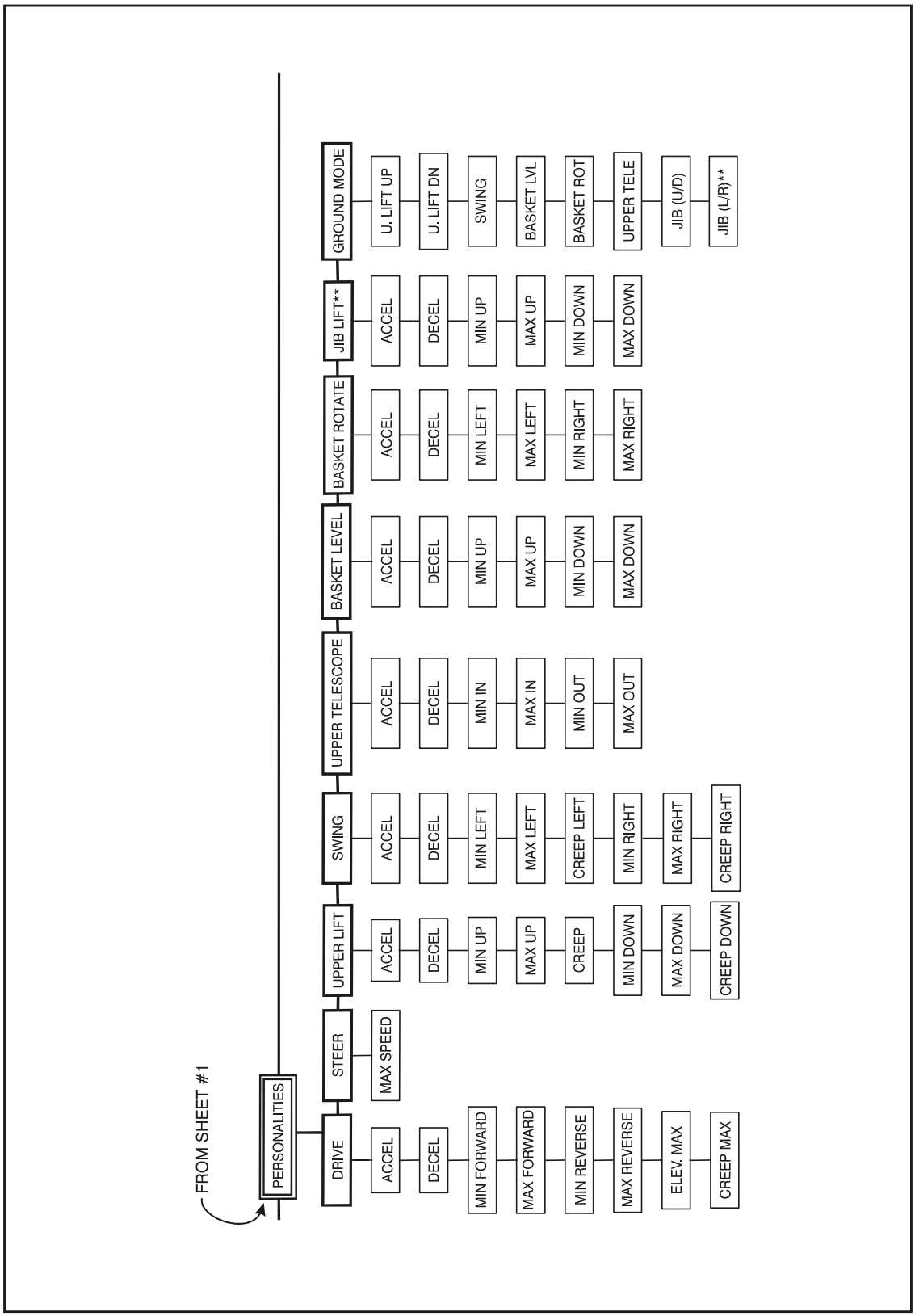


Figure 6-5. Analyzer Flow Chart - Sheet 2 of 3

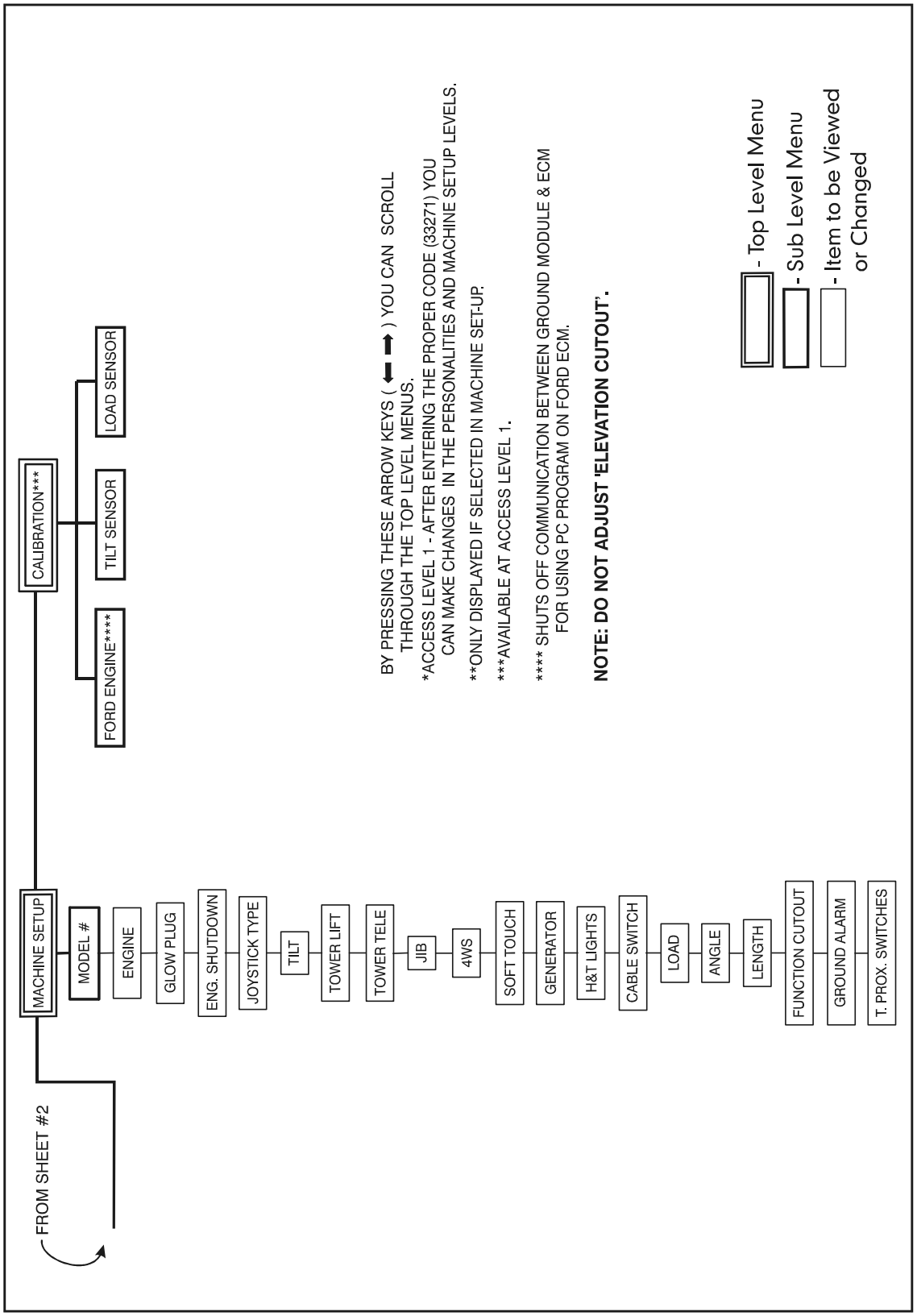


Figure 6-6. Analyzer Flow Chart - Sheet 3 of 3

6.8 MACHINE PERSONALITY SETTINGS

NOTE: *Personality settings can be adjusted within the adjustment range in order to achieve optimum machine performance.*

Table 6-1. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS
DRIVE	Accel	0.1s to 5.0s	2.0
	Decel	0.1s to 3.0s	2.0
	For Min	0 to 35%	4
	For Max	0 to 100%	22
	Rev Min	0 to 35%	4
	Rev Max	0 to 100%	22
	Elevated Max	0 to 50%	17
	Creep Max	0 to 50%	25
	Engine RPM	800 to 2900	1800
LIFT	Accel	0.1 to 5.0	2.0
	Decel	0.1 to 3.0	0.7
	Min Up	0 to 60%	40
	Max Up	0 to 100%	70
	Creep Up	0 to 65%	55
	Min Down	0 to 60%	40
	Max Down	0 to 100%	75
	Creep Down	0 to 75%	55
	Engine RPM	800 to 2900	1800
SWING	Accel	0.1 to 5.0s	2.0
	Decel	0.1 to 3.0s	1.8
	Min Left	0 to 50%	35
	Max Left	0 to 100%	69
	Creep Left	0 to 65%	35
	Min Right	0 to 50%	35
	Max Right	0 to 100%	73
	Creep Right	0 to 65%	45
	Engine RPM	800 to 2900	1400

Table 6-1. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS
TELESCOPE	Engine RPM	800 to 2900	1800
BASKET LEVEL	Engine RPM	800 to 2900	1500
BASKET ROTATE	Engine RPM	800 to 2900	1500
STEER	Max	0 to 100	100
	Engine RPM	800 to 2900	1800
GROUND MODE	Upper Lift Up	0 to 100%	60
	Upper Lift Down	0 to 100%	60
	Swing	0 to 100%	60

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Table 6-2. Help Fault Codes, Displayed Faults, and Descriptions - Prior to S/N 66939

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
None	No flash code is indicated for the following help messages. They are intended to hint at a possible problem if the vehicle is not behaving as expected.		1
	EVERYTHING OK	The “normal” help message in platform mode	
	GROUND MODE OK	The “normal” help message in ground mode	
	DRIVING AT CREEP - TILTED	Drive speed is limited to creep because the vehicle is tilted.	
	FSW OPEN	A drive or boom function has been selected but footswitch is open.	
	RUNNING AT CREEP - CREEP SWITCH OPEN	All function speeds are limited to creep because the creep switch is open.	
	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	All function speeds are limited to creep because the vehicle is tilted and above elevation.	
	RUNNING AT CUTBACK - ABOVE ELEVATION	Drive speed is limited to “ELEVATED MAX” because the vehicle is above elevation.	
	TESTS ACTIVE – RECYCLE EMS TO END	The system tests have been activated; normal vehicle operation is not allowed.	
1/1	Flash code 1/1 indicates a “sleep” mode. NOT REQUIRED		
2/1	Flash code 2/1 indicates problems with footswitch.		2
	FSW FAULTY	The two foot switch signals do not agree. EMS recycle required.	
	KEYSWITCH FAULTY	Both platform and ground modes are selected simultaneously	
2/2	Flash code 2/2 indicates problems with drive & steer selection.		3
	DRIVE JOYSTICK FAULTY	The drive joystick center tap is out of valid range, or the wiper is wire-off.	
	DRIVE LOCKED – JOYSTICK MOVED BEFORE EMS/FSW	Drive was selected before and during footswitch closure.	
	FSW INTERLOCK TRIPPED	Footswitch was closed for seven seconds with no function selected.	
	STEER LOCKED – SELECTED BEFORE EMS/FSW	Steer was selected before and during footswitch closure.	
	STEER SWITCHES FAULTY	Both steer switches are active together.	
	WAITING FOR FSW TO BE OPEN	Footswitch was closed when platform mode was selected.	
	JOYSTICK FAULTS – CHECK PLATFORM BOX WIRING	More than one of the drive, lift, and swing joystick center tap or wiper voltages is out of range. This is probably due to a short-circuit across a joystick pot.	

Table 6-2. Help Fault Codes, Displayed Faults, and Descriptions - Prior to S/N 66939

2/3	Flash code 2/3 indicates problems with boom function selection.		3
	LIFT/SWING JOYSTICK FAULTY	The lift or swing joystick center tap is out of valid range, or the wiper is wire-off.	
	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE EMS/FSW	Platform upper lift or swing was selected before and during foot-switch closure.	
	PUMP POT FAULTY	The pump pot is open-circuit; all platform boom functions except upper lift & swing will run at creep.	
	PUMP SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	A boom function (lower lift, telescope, basket level, basket rotate, jib) has both directions selected together.	
	PUMP SWITCHES LOCKED - SELECTED BEFORE EMS/FSW	A platform boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before key switch or footswitch closure.	
	PUMP SWITCHED LOCKED - SELECTED BEFORE EMS	A ground boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before key switch.	
	SWING/LIFT JOYSTICK FAULTY	The swing joystick center tap is out of valid range, or the wiper is wire-off.	
2/4	Flash code 2/4 indicates that steering digital inputs are faulty. NOT REQUIRED		
2/5	Flash code 2/5 indicates that a function is prevented due to a cutout.		4
	BOOM PREVENTED - DRIVE SELECTED	A boom function is selected while a drive function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED - ABOVE ELEVATION	Drive is selected while above elevation and drive cutout is configured to prevent drive.	
	DRIVE PREVENTED - BOOM MOVEMENT SELECTED	Drive is selected while a boom function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED - TILTED & ABOVE ELEVATION	Drive is selected while tilted and above elevation and tilt is configured to cutout drive.	
	BOOM PREVENTED – FUNCTION CUTOUT ACTIVE	A boom function is selected while function cutout is active and configured to cutout boom functions.	
	BOOM & DRIVE PREVENTED- FUNCTION CUTOUT ACTIVE	Drive or a boom function is selected while function cutout is active and configured to cutout all functions.	
2/7	Flash code 2/7 indicates that the accelerator input is faulty. NOT REQUIRED		
2/8	Flash code 2/8 indicates that the hydraulic filter is being bypassed.		5
	RETURN FILTER BYPASSED	Hydraulic return filter clogged	
	CHARGE PUMP FILTER BYPASSED	Charge pump filter clogged	
3/1	Flash code 3/1 indicates that a contactor did not close when energized. NOT REQUIRED		

Table 6-2. Help Fault Codes, Displayed Faults, and Descriptions - Prior to S/N 66939

3/2	Flash code 3/2 indicates that a contactor did not open when energized. NOT REQUIRED		
3/3	Flash code 3/3 indicates that a driver is short-circuit.		6
	ADD DRIVER FAULTS		
3/5	Flash code 3/5 indicates a brake pressure problem. NOT REQUIRED		7
4/2	Flash code 4/2 indicates that the engine is over temperature. NOT REQUIRED		8
4/3	Flash code 4/3 indicates problems with the engine		9
	ENGINE TEMP GREATER THAN 130°C (266° F)		
	AIR FILTER BYPASSED	Air filter clogged	
	NO aLTERNATOR OUTPUT	The measured battery voltage is less than 12.5 VDC	
	OIL PRESSURE LESS THAN 0.5 BAR (8PSI)		
4/4	Flash code 4/4 indicates problems with the battery supply.		7
	BATTERY LOW	Battery voltage is below 11V. This is a warning - the controller does not shut down.	
	BATTERY TOO HIGH - SYSTEM SHUT DOWN	Battery voltage is above 18V. EMS recycle required.	
	BATTERY TOO LOW - SYSTEM SHUT DOWN	Battery voltage is below 6V. EMS recycle required.	
5/5	Flash code 5/5 indicates problems with vehicle engine RPM or the encoder.		8
	SPEED SENSOR READING INVALID SPEED	Speed sensor is indicating an impossible number of pulses. This is probably due to a faulty speed sensor.	
	SPEED INPUT LOST	This indicates that the control system has determined that the diesel engine speed input to the system has been lost. This is probably due to wiring problems at the ground module or a faulty speed sensor.	
	ENGINE SPEED DOES NOT MATCH COMMAND	This indicates that the control system has determine that the diesel engine governor has stuck. This is probably due to electrical or mechanical problems with the governor.	
6/6	Flash code 6/6 indicates problems with the CAN bus.		10
	CAN BUS FAILURE:	The ground module or platform module is not receiving. This is probably due to wiring problems between the platform and ground modules.	
7/7	Flash code 7/7 indicates problems with a motor. NOT REQUIRED		

Table 6-2. Help Fault Codes, Displayed Faults, and Descriptions - Prior to S/N 66939

9/9	Flash code 9/9 indicates problems with the controller.		11
	PLATFORM MODULE FAILURE: hwfs CODE 1	Platform module V(Low) FET has failed	
	GROUND MODULE FAILURE: hwfs CODE 1	Ground module V(Low) FET has failed	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66939 to Present

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
None		**No flash code is indicated for the following help messages. They are intended to hint at a possible problem if the vehicle is not behaving as expected.**	1
	EVERYTHING OK	The "normal" help message in platform mode	
	GROUND MODE OK	The "normal" help message in ground mode	
	FSW OPEN	A drive or boom function has been selected but footswitch is open.	
	RUNNING AT CREEP – CREEP SWITCH OPEN	All function speeds are limited to creep because the creep switch is open.	
	RUNNING AT CREEP – TILTED AND ABOVE ELEVATION	All boom function speeds are limited to creep because the vehicle is tilted and above elevation.	
	RUNNING AT CUTBACK – ABOVE ELEVATION	Drive speed is limited to "ELEVATED MAX" because the vehicle is above elevation.	
	TILT SENSOR OUT OF RANGE	The tilt sensor has indicated a tilt angle greater than 19 degrees for more than 4 seconds. Not reported during 2 second power-up.	
	LOAD SENSOR READING UNDER WEIGHT	The load sensor is reading 20% or more under the calibrated zero point. This fault may occur if the basket is resting on the ground. Not reported during 2 second power-up.	
1/1		**Flash code 1/1 indicates a "sleep" mode. NOT REQUIRED**	
2/1		**Flash code 2/1 indicates problems with footswitch.**	2
	FSW FAULTY	The two footswitch inputs have read the same state for more than one second.	
	KEYSWITCH FAULTY	Both platform and ground modes are selected simultaneously	
2/2		**Flash code 2/2 indicates problems with drive & steer selection. Except where noted, these faults are not reported during 2 second power-up sequence.**	3
	DRIVE LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Drive was selected before and during footswitch closure. Can be reported during power-up sequence.	
	FSW INTERLOCK TRIPPED	Footswitch was closed for seven seconds with no function selected. Can be reported during power-up sequence.	
	STEER LOCKED – SELECTED BEFORE FOOTSWITCH	Steer was selected before and during footswitch closure.	
	STEER SWITCHES FAULTY	Both steer switches are active together.	
	DRIVE / STEER WITH NO QPROX	This fault only occurs with inductive joysticks. It occurs if the joystick is moved out of the neutral position with no Qprox sensors active.	
	D/S JOY. QPROX BAD	These faults only occur with inductive joysticks. They indicate that the Q-Prox sensor is reading above 3.18 volts.	
	D/S JOY. OUT OF RANGE LOW	Resistive joysticks: These faults do not occur. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is less than the centertap voltage minus half the center tap voltage minus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered below 1.05 volts. If the centertap is at the low end of the range, these faults will be triggered below 0.79 volts.	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66939 to Present

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	D/S JOY. OUT OF RANGE HIGH	Resistive joysticks: These faults do not occur if the Vref voltage is below 8.1 volts. If Vref is above 7.7 volts, Vref is operating out of tolerance or a short to battery has occurred. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is more than the centertap voltage plus half the centertap voltage plus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered above 4.35 volts. If the centertap is at the low end of the range, these faults will be triggered above 3.8 volts.	
	D/S JOY. CENTER TAP BAD	Resistive joysticks: These faults occur when the center tap voltage is not between 3.08 volts and 3.83 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated. Inductive joysticks: These faults occur when the center tap voltage is not between 2.18 volts and 2.70 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated.	
	WAITING FOR FSW TO BE OPEN	Footswitch was closed when platform mode was selected. Can be reported during power-up sequence.	
2/3		**Flash code 2/3 indicates problems with boom function selection.**	**3**
	LIFT/SWING LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Platform upper lift or swing was selected before and during footswitch closure.	
	PUMP SWITCHES FAULTY – CHECK DIAGNOSTICS/ BOOM	A boom function (lower lift, telescope, basket level, basket rotate, jib) has both directions selected together.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE FOOTSWITCH	A platform boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before key switch or footswitch closure.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE AUX POWER	A ground boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before aux power.	
	LIFT / SWING WITH NO QPROX	This fault only occurs with inductive joysticks. It occurs if the joystick is moved out of the neutral position with no Qprox sensors active.	
	l/s joy. qprox bad	These faults only occur with inductive joysticks. They indicate that the Q-Prox sensor is reading above 3.18 volts.	
	l/s joy. out of range low	Resistive joysticks: These faults do not occur. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is less than the centertap voltage minus half the center tap voltage minus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered below 1.05 volts. If the centertap is at the low end of the range, these faults will be triggered below 0.79 volts.	
	l/s joy. out of range high	Resistive joysticks: These faults do not occur if the Vref voltage is below 8.1 volts. If Vref is above 7.7 volts, Vref is operating out of tolerance or a short to battery has occurred. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is more than the centertap voltage plus half the centertap voltage plus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered above 4.35 volts. If the centertap is at the low end of the range, these faults will be triggered above 3.8 volts.	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66939 to Present

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	l/s joy. center tap bad	Resistive joysticks: These faults occur when the center tap voltage is not between 3.08 volts and 3.83 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated. Inductive joysticks: These faults occur when the center tap voltage is not between 2.18 volts and 2.70 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE START SWTICH	This fault occurs when a hydraulic function switch is closed before the start switch is closed.	
	FOOTSWITCH SELECTED BEFORE START	The user attempted to start the machine with the footswitch engaged.	
2/4		**Flash code 2/4 indicates that steering digital inputs are faulty. NOT REQUIRED**	
2/5		**Flash code 2/5 indicates that a function is prevented due to a cutout.**	**4**
	BOOM PREVENTED – DRIVE SELECTED	A boom function is selected while a drive function is selected and drive cut-out is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED – ABOVE ELEVATION	Drive is selected while above elevation and drive cutout is configured to prevent drive.	
	DRIVE PREVENTED – BOOM SELECTED	Drive is selected while a boom function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED – TILTED & ABOVE ELEVATION	Drive is selected while tilted and above elevation and tilt is configured to cutout drive.	
	MODEL CHANGED – HYDRAULICS SUSPENDED – CYCLE EMS	User changed the model number using the analyzer. User must cycle power before the hydraulics system will be active again.	**11**
2/7		**Flash code 2/7 indicates that the accelerator input is faulty. NOT REQUIRED**	
2/8		**Flash code 2/8 indicates a problem with a hydraulic filter. Not reported during 2 second power-up.**	**5**
	RETURN FILTER BYPASSED	Hydraulic return filter clogged	
	charge pump filter bypassed	Charge pump filter clogged	
3/1		**Flash code 3/1 indicates that a contactor did not close when energized. NOT REQUIRED**	
3/2		**Flash code 3/2 indicates that a contactor did not open when energized. NOT REQUIRED**	
3/3		**Flash code 3/3 indicates a driver problem. All driver faults are detected in a similar manner. Open circuit faults are detected when the analog feedback reads too high and the output is commanded off. Short to ground is detected when the analog feedback reads low and the output is commanded on. Short to battery is detected when the analog feedback reads Vbat and the output is commanded off. Not reported during 2 second power-up.**	**6**
	ALTERNATOR/ECM POWER SHORT TO GROUND		
	HOUR METER SHORT TO GROUND		

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66939 to Present

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	HOUR METER SHORT TO BATTERY		
	HORN SHORT TO GROUND		
	HORN OPEN CIRCUIT		
	HORN SHORT TO BATTERY		
	AUX POWER SHORT TO GROUND		
	AUX POWER OPEN CIRCUIT		
	AUX POWER SHORT TO BATTERY		
	GLOW PLUG SHORT TO GROUND		
	GLOW PLUG OPEN CIRCUIT		
	GLOW PLUG SHORT TO BATTERY		
	LP LOCK SHORT TO GROUND		
	LP LOCK OPEN CIRCUIT		
	LP LOCK SHORT TO BATTERY		
	LP START ASSIST SHORT TO GROUND		
	LP START ASSIST OPEN CIRCUIT		
	LP START ASSIST SHORT TO BATTERY		
	MAIN DUMP SHORT TO GROUND		
	MAIN DUMP OPEN CIRCUIT		
	MAIN DUMP SHORT TO BATTERY		
	PARKING BRAKE SHORT TO GROUND		
	PARKING BRAKE OPEN CIRCUIT		
	PARKING BRAKE SHORT TO BATTERY		
	START SOLENOID SHORT TO GROUND		
	START SOLENOID OPEN CIRCUIT		
	START SOLENOID SHORT TO BATTERY		
	STEER DUMP SHORT TO GROUND		

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66939 to Present

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	STEER DUMP OPEN CIRCUIT		
	STEER DUMP SHORT TO BATTERY		
	TWO SPEED SHORT TO GROUND		
	TWO SPEED OPEN CIRCUIT		
	TWO SPEED SHORT TO BATTERY		
	GROUND ALARM SHORT TO GROUND		
	GROUND ALARM OPEN CIRCUIT		
	GROUND ALARM SHORT TO BATTERY		
	GENERATOR SHORT TO GROUND		
	GENERATOR OPEN CIRCUIT		
	GENERATOR SHORT TO BATTERY		
	WELDER SHORT TO GROUND		
	WELDER OPEN CIRCUIT		
	WELDER SHORT TO BATTERY		
	HEAD TAIL LIGHT SHORT TO GROUND		
	HEAD TAIL LIGHT OPEN CIRCUIT		
	HEAD TAIL LIGHT SHORT TO BATTERY		
	BASKET UP OVERRIDE SHORT TO GROUND	Only occurs on machines with electronic leveling systems.	
	BASKET UP OVERRIDE OPEN CIRCUIT	Only occurs on machines with electronic leveling systems.	
	BASKET UP OVERRIDE SHORT TO BATTERY	Only occurs on machines with electronic leveling systems.	
	BASKET UP SHORT TO GROUND		
	BASKET UP OPEN CIRCUIT		
	BASKET UP SHORT TO BATTERY		
	BASKET DOWN SHORT TO GROUND		
	BASKET DOWN OPEN CIRCUIT		

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66939 to Present

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	BASKET DOWN SHORT TO BATTERY		
	BASKET DOWN OVERRIDE SHORT TO GROUND	Only occurs on machines with electronic leveling systems.	
	BASKET DOWN OVERRIDE OPEN CIRCUIT	Only occurs on machines with electronic leveling systems.	
	BASKET DOWN OVERRIDE SHORT TO BATTERY	Only occurs on machines with electronic leveling systems.	
	BASKET LEFT OPEN CIRCUIT		
	BASKET LEFT SHORT TO BATTERY		
	BASKET LEFT SHORT TO GROUND		
	BASKET RIGHT SHORT TO GROUND		
	BASKET RIGHT OPEN CIR-CUIT		
	BASKET RIGHT SHORT TO BATTERY		
	JIB UP SHORT TO GROUND		
	JIB UP OPEN CIRCUIT		
	JIB UP SHORT TO BATTERY		
	JIB DOWN SHORT TO GROUND		
	JIB DOWN OPEN CIRCUIT		
	JIB DOWN SHORT TO BAT-TERY		
	JIB LEFT SHORT TO GROUND		
	JIB LEFT OPEN CIRCUIT		
	JIB LEFT SHORT TO BAT-TERY		
	JIB RIGHT SHORT TO GROUND		
	JIB RIGHT OPEN CIRCUIT		
	JIB RIGHT SHORT TO BAT-TERY		
	TOWER UP SHORT TO GROUND		
	TOWER UP OPEN CIRCUIT		
	TOWER UP SHORT TO BAT-TERY		
	TOWER DOWN SHORT TO GROUND		

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66939 to Present

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	TOWER DOWN OPEN CIRCUIT		
	TOWER DOWN SHORT TO BATTERY		
	TOWER IN SHORT TO GROUND		
	TOWER IN OPEN CIRCUIT		
	TOWER IN SHORT TO BATTERY		
	TOWER OUT SHORT TO GROUND		
	TOWER OUT OPEN CIRCUIT		
	TOWER OUT SHORT TO BATTERY		
	UPPER IN SHORT TO GROUND		
	UPPER IN OPEN CIRCUIT		
	UPPER IN SHORT TO BATTERY		
	UPPER OUT SHORT TO GROUND		
	UPPER OUT OPEN CIRCUIT		
	UPPER OUT SHORT TO BATTERY		
	LIFT UP DUMP SHORT TO GROUND		
	LIFT UP DUMP OPEN CIRCUIT		
	LIFT UP DUMP SHORT TO BATTERY		
	LIFT DOWN HOLDING SHORT TO GROUND		
	LIFT DOWN HOLDING OPEN CIRCUIT		
	LIFT DOWN SHORT TO BATTERY		
	HOUR METER OPEN CIRCUIT	This fault cannot be detected during normal operation. It may be reported during self test.	
	FORD ECM POWER OPEN CIRCUIT	This fault cannot be detected during normal operation. It may be reported during self test.	
	FORD ECM POWER SHORT TO BATTERY	This fault cannot be detected during normal operation. It may be reported during self test.	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66939 to Present

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
3/4		**Flash code 3/4 indicates a driver problem on a platform valve block valve driver. All driver faults are detected in a similar manner. Open circuit faults are detected when the analog feedback reads too high and the output is commanded off. Short to ground is detected when the analog feedback reads low and the output is commanded on. Short to battery is detected when the analog feedback reads Vbat and the output is commanded off. Not reported during 2 second power-up.**	6
	BASKET UP SHORT TO BATTERY		
	BASKET UP SHORT TO GROUND		
	BASKET UP OPEN CIRCUIT		
	BASKET UP SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling	
	BASKET DOWN SHORT TO BATTERY		
	BASKET DOWN SHORT TO GROUND		
	bASKET DOWN OPEN CIRCUIT		
	BASKET DOWN SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling.	
	BASKET LEFT SHORT TO BATTERY		
	BASKER LEFT SHORT TO GROUND		
	BASKET LEFT OPEN CIRCUIT		
	BASKET RIGHT SHORT TO BATTERY		
	BASKET RIGHT SHORT TO GROUND		
	BASKET RIGHT OPEN CIRCUIT		
	JIB UP SHORT TO BATTERY		
	JIB UP SHORT TO GROUND		
	JIB UP OPEN CIRCUIT		
	JIB DOWN SHORT TO BATTERY		
	JIB DOWN SHORT TO GROUND		
	JIB DOWN OPEN CIRCUIT		
	JIB LEFT SHORT TO BATTERY		
	JIB LEFT SHORT TO GROUND		

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66939 to Present

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	JIB LEFT OPEN CIRCUIT		
	JIB RIGHT SHORT TO BATTERY		
	JIB RIGHT SHORT TO GROUND		
	JIB RIGHT OPEN CIRCUIT		
	PLATFORM CONTROL VALVE SHORT TO BATTERY	Only occurs on machines with electronic basket leveling	
	PLATFORM CONTROL VALVE SHORT TO GROUND	Only occurs on machines with electronic basket leveling	
	PLATFORM CONTROL VALVE OPEN CIRCUIT	Only occurs on machines with electronic basket leveling	
3/5		**Flash code 3/5 indicates a brake pressure problem. NOT REQUIRED**	
4/2		**Flash code 4/2 indicates that the engine is over temperature. NOT REQUIRED**	
4/3		**Flash code 4/3 indicates problems with the engine. Except where noted, these faults are not reported during 2 second power-up sequence.**	**9**
	high engine temp	Occurs when the engine temperature is above 117 degrees Celsius for the Ford engines, and above 130 degrees Celsius for the Deutz engines.	
	AIR FILTER BYPASSED	Air filter clogged	
	NO aLTERNATOR OUTPUT	The engine has been running for 15 seconds or more and the battery voltage is still below 12.5 volts.	
	LOW Oil PrESSURE	If a Deutz engine is installed, the oil pressure is below 8 PSI and the engine has been running for at least 10 seconds. If a Ford engine is installed, the Ford ECM has reported a low oil pressure fault.	
	OIL PRESSURE SHORT TO BATTERY	If a Deutz engine is installed, this indicates that the oil pressure sensor is reading above 6.6 volts.	
	OIL PRESSURE SHORT TO GROUNd	If a Deutz engine is installed, this indicates that the oil pressure sensor is reading below 0.1 volts for more than 5 seconds. This fault is not detected during crank.	
	COOLANT TEMPERATURE SHORT TO GROUND	If a Deutz engine is installed, this indicates that the coolant temperature is reading below 0.1 volts.	
	FORD FAULT CODE ##	All Ford fault codes except 63 are simply passed through from the FORD ECM. They only occur if a Ford engine is selected in the machine configuration digits. Can be reported during power-up sequence.	
	FORD FAULT CODE UNKNOWN	An unrecognized Ford ECM fault code has been received. Can be reported during power-up sequence.	
	485 communications lost	This fault only occurs with a Ford engine. It occurs when no responses are received from the ECM for 2.5 seconds. Can be reported during power-up sequence.	
	FUEL SENSOR SHORT TO BATTERY	Indicates that the fuel sensor is reading above 4.3 volts.	
	FUEL SENSOR SHORT TO GROUND	Indicates that the fuel sensor is reading below 0.2 volts.	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66939 to Present

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
4/4		**Flash code 4/4 indicates problems with the battery supply. Not reported during 2 second power-up.**	**7**
	BATTERY LOW	Battery voltage is below 11V for more than 5 seconds. This fault is not detected during crank. This is a warning – the controller does not shut down.	
	BATTERY TOO HIGH – SYSTEM SHUT DOWN	Battery voltage is above 16V. EMS recycle required.	
	BATTERY TOO LOW – SYSTEM SHUT DOWN	Battery voltage is below 9V.	
5/5		**Flash code 5/5 indicates problems with vehicle engine RPM or the encoder. Not reported during 2 second power-up.**	**8**
	SPEED SENSOR READING INVALID SPEED	This fault is detected with diesel engines only. The RPM pickup is indicating a speed that greater than 4000 RPM or approximately 8875 Hz.	
	SPEED INPUT LOST	This fault is detected with diesel engines only. It occurs if there is no RPM detected and the oil pressure input is reading above 8 PSI for more than three seconds. This is probably due to wiring problems at the ground module or a faulty speed sensor.	
6/6		**Flash code 6/6 indicates problems with the CAN bus.**	**10**
	CAN BUS FAILURE:	The ground module or platform module is not receiving CAN messages. This is probably due to wiring problems between the platform and ground modules.	
7/7		**Flash code 7/7 indicates problems with a motor. NOT REQUIRED**	
9/9		**Flash code 9/9 indicates problems with the controller.**	**11**
	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	Platform module code is too old to support the EIM or BPE load sensor and the machine is configured to use one of these two sensors. The PM code must be updated to a newer version.	
	HIGH RESOLUTION A2D FAILURE –INTERRUPT LOST	The ADS1213 chip in the platform module has stopped asserting its interrupt (DRDY) line for some reason. An EMS cycle is required.	
	HIGH RESOLUTION A2D FAILURE-REINIT LIMIT	The ADS1213 has needed to be reset 3 or more times.	
	PLATFORM MODULE FAILURE: hwfs CODE 1	Platform module V(Low) FET has failed	
	GROUND MODULE FAILURE: hwfs CODE 1	Ground module V(Low) FET has failed	
	GROUND SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for the joysticks, sensors, etc. goes out of range. Not reported during 2 second power-up.	
	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for the joysticks, sensors, etc. goes out of range. Not reported during 2 second power-up.	
	EEPROM FAILURE – CHECK ALL SETTINGS	A critical failure occurred with the EEPROM. Personalities, machine configuration digits, etc. may be reset to default values and should be checked.	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions - S/N 66939 to Present

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	Indicates that the chassis tilt sensor calibration information has been lost. Machine will indicate that it is tilted at all times. This calibration data is programmed into the unit at the factory.	
	CHASSIS TILT SENSOR GAIN OUT OF RANGE	Indicates that the chassis tilt sensor calibration has become corrupted.	

Table 6-4. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
1 (Model #)	1 2 3 4 5 6 7 8	400 450, 510 600 601 800A 800S 1350SJP 1200SJP	1
2 (Engine)	1 2 3 4	Ford LRG425 EFI Gas Ford LRG425 EFI Gas with duel fuel Deutz F4M1011F Diesel Deutz F3M1011F Diesel	1
3 (Glow Plugs)	0 1-60	No Glow Plugs Installed Setting this number tells the controller how many minutes after the EMS is pulled to output to the glowplugs before allowing the start engine function.	0
4 (Engine Shutdown)	0 1	No Engine Shutdown Shutdown engine when coolant temperature is greater than 112 deg. C or the oil pressure is less than 8 psi.	1
5 (Joystick Type)	0 1	Resistive Joysticks Installed Inductive Joysticks Installed	0
6 (Tilt Switch)	1 2 3 4 5 Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is tilted and above elevation.	5 degree-reduces the maximum speed of all boom functions to creep when tilted and above elevation. Reduces drive speed to creep when tilted. ANSI (US); ANSI (EXPORT); CSA; JAPAN –All Models 4 degree-reduces the maximum speed of all boom functions to creep when tilted and above elevation. Reduces drive speed to creep when tilted. CE; AUSTRALIA – 400S, 450, & 800S 3 degree-reduces the maximum speed of all boom functions to creep when tilted and above elevation. Reduces drive speed to creep when tilted. CE; AUSTRALIA – 600, 601, and 800A 4 degree - reduces the maximum speed of all boom functions to creep when tilted and above elevation and disallows tower lift up, drive, upper telescope out and upper lift up 3 degree - reduces the maximum speed of all boom functions to creep when tilted and above elevation and disallows tower lift up, drive, upper telescope out, and upper lift up.	1
7 (Tower Lift)	0 1	No Tower Lift Installed Yes	0
8 (Tower Tele)	0 1	No Tower Telescope Installed Yes	0

Table 6-4. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
9 (Jib)	0 1 2	No JIB installed. JIB installed which has up and down movements only. JIB installed which has up and down movements and side to side movements.	0
10 (4WS)	0 1	No Four-Wheel Steer installed. Yes	0
11 (Soft Touch System)	0 1	No Soft Touch System Installed Yes	0
12 (Generator/Welder)	0 1 2	No Generator Installed Yes - 2500W or 7500W generator installed Yes - Welder Installed	0
13 (Head and Tail Lights)	0 1	No Head and Tail Lights Installed Yes	0
14 (Broken Cable Switch Installed)	0 1	No Broken Cable Switch Installed Yes	0
15 (Load Sensor)	0 1 2 3	No Load Sensor installed - (DOM - STD) Functions in Creep, Overload Lamp Lit, Platform Alarm Beeps Continuously All functions cutout, flash overload light (500mS on, 500mS off), Platform Alarm beeps (5 sec on, 55 sec off, 5 sec on) - (CE-STD) Functions in Creep, Overload Lamp Lit, Platform Alarm beeps continuously, disable upper telescope out and upper lift up	0
16 (Angle Sensor)	1	Digital Angle Sensor Installed	1
17 (Length Sensor)	1	Digital Length Sensor Installed	1
18 (Function Cutout)	0 1 2 3	No Drive Cutout - (DOM - STD) Boom function cutout while driving above elevation - (CE - STD) Drive Cutout above elevation Drive Cutout above elevation and tilted	0
19 (Ground Alarm)	0 1 2 3	No ground alarm installed. Travel alarm- Sounds when the drive function is active. **Option** Descent Alarm- Sounds when either lift down is active. **Option** Motion alarm- Sounds when any function is active. **Option**	0
20 (Tower Prox Switches)	0 1	No Tower Prox Switches Installed Tower Prox Switches Installed 450A, 510, 600A, 800A	0
21 (Flywheel Teeth)	0 1	133 Teeth (F3M Prior to 11-16-01; F4M1011 Prior to 1-1-02) 110 Teeth (Deutz 2011, F3M after 11-16-01; F4M1011 after 1-1-02	0
22 (Oscillating Axle)	0 1	No - Oscillating axle installed Yes - Oscillating axle installed	0

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Table 6-5. Fault Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
OK	0	0	CLEARS WHEN FAULT IS REMOVED
DRIVING AT CREEP - TILTED	0	0	CLEARS WHEN FAULT IS REMOVED
FSW OPEN	0	0	CLEARS WHEN FAULT IS REMOVED
RUNNING AT CREEP - CREEP SWITCH OPEN	0	0	CLEARS WHEN FAULT IS REMOVED
RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	0	0	CLEARS WHEN FAULT IS REMOVED
RUNNING AT CUTBACK - ABOVE ELEVATION	0	0	CLEARS WHEN FAULT IS REMOVED
TILT SENSOR OUT OF RANGE	0	0	CLEARS WHEN FAULT IS REMOVED
LOAD SENSOR READING UNDER WEIGHT	0	0	CLEARS WHEN FAULT IS REMOVED
FSW FAULTY	2	1	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
KEYSWITCH FAULTY	2	1	CLEARS WHEN FAULT IS REMOVED
DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	2	2	CLEARS WHEN FAULT IS REMOVED
FSW INTERLOCK TRIPPED	2	2	CLEARS WHEN FAULT IS REMOVED
STEER LOCKED - SELECTED BEFORE FOOTSWITCH	2	2	CLEARS WHEN FAULT IS REMOVED
STEER SWITCHES FAULTY	2	2	CLEARS WHEN FAULT IS REMOVED
D/S JOY. QPROX BAD	2	2	CLEARS WHEN FAULT IS REMOVED
L/S JOY. QPROX BAD	2	3	CLEARS WHEN FAULT IS REMOVED
D/S JOY. OUT OF RANGE LOW	2	2	CLEARS WHEN FAULT IS REMOVED
D/S JOY. OUT OF RANGE HIGH	2	2	CLEARS WHEN FAULT IS REMOVED
L/S JOY. OUT OF RANGE LOW	2	3	CLEARS WHEN FAULT IS REMOVED
L/S JOY. OUT OF RANGE HIGH	2	3	CLEARS WHEN FAULT IS REMOVED
D/S JOY. CENTER TAP BAD	2	2	CLEARS WHEN FAULT IS REMOVED
L/S JOY. CENTER TAP BAD	2	3	CLEARS WHEN FAULT IS REMOVED
WAITING FOR FSW TO BE OPEN	2	2	CLEARS WHEN FAULT IS REMOVED
PUMP POT FAULTY	2	3	CLEARS WHEN FAULT IS REMOVED
PUMP SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	2	3	CLEARS WHEN FAULT IS REMOVED
PUMP SWITCHES LOCKED - SELECTED BEFORE FOOTSWITCH	2	3	CLEARS WHEN FAULT IS REMOVED
PUMP SWITCHES LOCKED - SELECTED BEFORE START SWITCH	2	3	CLEARS WHEN FAULT IS REMOVED
FOOTSWITCH SELECTED BEFORE START	2	3	CLEARS WHEN FAULT IS REMOVED
BOOM PREVENTED - DRIVE SELECTED	2	5	CLEARS WHEN FAULT IS REMOVED
DRIVE PREVENTED - ABOVE ELEVATION	2	5	CLEARS WHEN FAULT IS REMOVED
DRIVE PREVENTED - TILTED & ABOVE ELEVATION	2	5	CLEARS WHEN FAULT IS REMOVED
DRIVE PREVENTED - BOOM SELECTED	2	5	CLEARS WHEN FAULT IS REMOVED

Table 6-5. Fault Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
FORD ECM POWER SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HORN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HORN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HORN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PARKING BRAKE SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PARKING BRAKE OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PARKING BRAKE SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
ALARM SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
ALARM OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT

Table 6-5. Fault Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
ALARM SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GENERATOR SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GENERATOR OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GENERATOR SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HEAD TAIL LIGHT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HEAD TAIL LIGHT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HEAD TAIL LIGHT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HOUR METER SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HOUR METER SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB DOWN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB DOWN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB DOWN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT

Table 6-5. Fault Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
TOWER UP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER UP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER UP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER IN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER IN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER IN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
FUEL SENSOR SHORT TO BATTERY	3	3	CLEARS WHEN FAULT IS REMOVED
FUEL SENSOR SHORT TO GROUND	3	3	CLEARS WHEN FAULT IS REMOVED
OIL PRESSURE SHORT TO BATTERY	4	3	CLEARS WHEN FAULT IS REMOVED
OIL PRESSURE SHORT TO GROUND	4	3	CLEARS WHEN FAULT IS REMOVED
COOLANT TEMPERATURE SHORT TO GROUND	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 12	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 13	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 14	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 15	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 21	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 22	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 23	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 24	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 25	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 26	4	3	CLEARS WHEN FAULT IS REMOVED

Table 6-5. Fault Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
FORD FAULT CODE 31	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 32	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 33	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 34	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 35	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 36	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 41	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 42	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 43	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 44	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 45	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 46	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 51	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 52	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 53	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 54	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 55	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 56	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 57	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 61	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 62	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 63	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 64	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE UNKNOWN	4	3	CLEARS WHEN FAULT IS REMOVED
RETURN FILTER BYPASSED	2	8	CLEARS WHEN FAULT IS REMOVED
CHARGE PUMP FILTER BYPASSED	2	8	CLEARS WHEN FAULT IS REMOVED
BATTERY LOW	4	4	CLEARS WHEN FAULT IS REMOVED
BATTERY TOO HIGH - SYSTEM SHUT DOWN	4	4	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BATTERY TOO LOW - SYSTEM SHUT DOWN	4	4	CLEARS WHEN FAULT IS REMOVED
SPEED SENSOR READING INVALID SPEED	5	5	CLEARS WHEN FAULT IS REMOVED
SPEED INPUT LOST	5	5	CLEARS WHEN FAULT IS REMOVED
ENGINE TEMP HIGH	4	3	CLEARS WHEN FAULT IS REMOVED
AIR FILTER BYPASSED	4	3	CLEARS WHEN FAULT IS REMOVED

Table 6-5. Fault Code Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
NO ALTERNATOR OUTPUT	4	3	CLEARS WHEN FAULT IS REMOVED
OIL PRESSURE LOW	4	3	CLEARS WHEN FAULT IS REMOVED
485 COMMUNICATIONS LOST	4	3	CLEARS WHEN FAULT IS REMOVED
CAN BUS FAILURE	6	6	CLEARS WHEN FAULT IS REMOVED
LOAD SENSOR NOT CALIBRATED	9	9	CLEARS WHEN FAULT IS REMOVED
TILT SENSOR NOT CALIBRATED	9	9	CLEARS WHEN FAULT IS REMOVED
EEPROM FAILURE - CHECK ALL SETTINGS	9	9	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PLATFORM MODULE FAILURE: HWFS CODE 1	9	9	CLEARS WHEN FAULT IS REMOVED
GROUND MODULE FAILURE: HWFS CODE 1	9	9	CLEARS WHEN FAULT IS REMOVED

6.9 ANALYZER DIAGNOSTICS MENU STRUCTURE

In the following structure descriptions, an intended item is selected by pressing ENTER; pressing ESC steps back to the next outer level. The LEFT/RIGHT arrow keys move between items in the same level. The UP/DOWN arrow keys alter a value if allowed

Table 6-6. ADJUSTMENTS - Personality Descriptions

DRIVE	
ACCEL …	Displays/adjusts drive acceleration
DECEL …	Displays/adjusts drive deceleration
MIN FORWARD …	Displays/adjusts minimum forward drive speed
MAX FORWARD …	Displays/adjusts maximum forward drive speed
MIN REVERSE …	Displays/adjusts minimum reverse drive speed
MAX REVERSE …	Displays/adjusts maximum reverse drive speed
ELEVATED MAX …	Displays/adjusts maximum drive speed NOTE: used when elevation cutout switches are limiting maximum speed
CREEP MAX …	Displays/adjusts maximum drive speed NOTE: used when creep switch on pump pot is active
STEER MAX …	Displays/adjusts the maximum steer speed
LIFT	
ACCEL …	Displays/adjusts upper lift acceleration
DECEL …	Displays/adjusts upper lift deceleration
MIN UP …	Displays/adjusts minimum upper lift up speed
MAX UP …	Displays/adjusts maximum upper lift up speed
CREEP UP …	Displays/adjusts maximum upper lift up speed NOTE: used when creep switch on pump pot is active
MIN DOWN …	Displays/adjusts minimum upper lift down speed
MAX DOWN …	Displays/adjusts maximum upper lift down speed
CREEP DOWN …	Displays/adjusts maximum upper lift down speed NOTE: used when creep switch on pump pot is active

Table 6-6. ADJUSTMENTS - Personality Descriptions

SWING	
ACCEL …	Displays/adjusts swing acceleration
DECEL …	Displays/adjusts swing deceleration
MIN LEFT …	Displays/adjusts minimum swing left speed
MAX LEFT …	Displays/adjusts maximum swing left speed
CREEP LEFT …	Displays/adjusts maximum swing left speed NOTE: used when creep switch on pump pot is active
MIN RIGHT …	Displays/adjusts minimum swing right speed
MAX RIGHT …	Displays/adjusts maximum swing right speed
CREEP RIGHT …	Displays/adjusts maximum swing right speed NOTE: used when creep switch on pump pot is active
UPPER TELESCOPE	
ACCEL …	Displays/adjusts telescope acceleration
DECEL …	Displays/adjusts telescope deceleration
MIN IN …	Displays/adjusts minimum telescope in speed
MAX IN …	Displays/adjusts maximum telescope in speed
MIN OUT …	Displays/adjusts minimum telescope out speed
MAX OUT …	Displays/adjusts maximum telescope out speed
BASKET LEVEL	
ACCEL …	Displays/adjusts basket level acceleration
DECEL …	Displays/adjusts basket level deceleration
MIN UP …	Displays/adjusts minimum basket level up speed
MAX UP …	Displays/adjusts maximum basket level up speed
MIN DOWN …	Displays/adjusts minimum basket level down speed
MAX DOWN …	Displays/adjusts maximum basket level down speed
BASKET ROTATE	
ACCEL …	Displays/adjusts basket rotate acceleration
DECEL …	Displays/adjusts basket rotate deceleration
MIN LEFT …	Displays/adjusts minimum basket rotate left speed
MAX LEFT …	Displays/adjusts maximum basket rotate left speed
MIN RIGHT …	Displays/adjusts minimum basket rotate right speed
MAX RIGHT …	Displays/adjusts maximum basket rotate right speed

Table 6-6. ADJUSTMENTS - Personality Descriptions

JIB LIFT	Not displayed if JIB = NO
ACCEL …	Displays/adjusts jib acceleration
DECEL …	Displays/adjusts jib deceleration
MIN UP …	Displays/adjusts minimum jib up speed
MAX UP …	Displays/adjusts maximum jib up speed
MIN DOWN …	Displays/adjusts minimum jib down speed
MAX DOWN …	Displays/adjusts maximum jib down speed
MIN LEFT …	Displays/adjusts minimum jib left speed
MAX LEFT …	Displays/adjusts maximum jib left speed
MIN RIGHT …	Displays/adjusts minimum jib right speed
MAX RIGHT …	Displays/adjusts maximum jib right speed
STEER	
MAX SPEED …	Displays/adjusts maximum steer speed, which applies when vehicle speed is at minimum
GROUND MODE	
LIFT UP …	Displays/adjusts fixed lift up speed
LIFT DOWN …	Displays/adjusts fixed lift down speed
SWING …	Displays/adjusts fixed swing speed
TELE …	Displays/adjusts fixed telescope speed
BASKETLEVEL …	Displays/adjusts fixed basket level speed
BASKETROTATE …	Displays/adjusts fixed basket rotate speed
JIB (U/D) …	Displays/adjusts jib lift speed Not displayed if JIB = NO
JIB (L/R)…	Displays/adjusts jib swing speed Not displayed if JIB = NO

Table 6-7. Diagnostic Menu Descriptions

DRIVE	
DRIVE FOR …	Displays drive joystick direction & demand
STEER …	Displays steer switch direction & demand NOTE: steer demand is inversely proportional to vehicle speed
BRAKES …	Displays brake control system status
CREEP …	Displays pump pot creep switch status
TWO SPEED...	Displays two speed switch status
2 SPEED MODE	Displays status of two speed valve
HIGH ENGINE	Displays high engine switch status
BOOM	
U LIFT UP …	Displays lift joystick direction & demand
SWING LEFT …	Displays swing joystick direction & demand
LEVEL UP …	Displays basket level switch direction & demand NOTE: demand is controlled by the pump pot
ROT. LEFT …	Displays basket rotate switch direction & demand NOTE: demand is controlled by the pump pot
U TELE IN …	Displays telescope switch direction & demand NOTE: demand is controlled by the pump pot
JIB UP …	Displays jib lift switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
JIB LEFT …	Displays jib swing switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
PUMP POT …	Displays pump pot demand
ENGINE	
START …	Displays start switch status
AIR FILTER …	Displays air filter status
BATTERY …	Displays measured battery voltage
COOLANT …	Displays coolant temperature
OIL PRS …	Displays oil pressure status
FUEL SELECT …	Displays selected fuel (Dual Fuel only)
FUEL LEVEL …	Displays fuel level status
RPM	Displays Engine RPM
GM BATTERY	Displays battery voltage at ground module

Table 6-7. Diagnostic Menu Descriptions

PM BATTERY …	Displays battery voltage at platform module
TEMP..	Displays ground module temperature
ELEV. CUTOUT …	Displays elevation cutout switch status
FUNC. CUTOUT …	Displays function cutout switch status
CREEP…	Displays creep switch status
TILT …	Displays measured vehicle tilt
AUX POWER …	Displays status of auxiliary power switch
HORN …	Displays status of horn switch
R FILTER …	Displays status of return filter switch
C FILTER …	Displays status of charge pump filter
LOAD LENGTH …	Displays length switch status
ANGLE …	Displays angle switch status
LOAD …	Displays load sensor value NOTE: Not displayed if load = 0.
DATALOG	
ON …	Displays total controller on (EMS) time
ENGINE …	Displays engine run time
DRIVE …	Displays total controller drive operation time
LIFT …	Displays total controller lift operation time
SWING …	Displays total controller swing operation time
TELE …	Displays total controller tele operation time
MAX.TEMP …	Displays maximum measured heatsink temp.
MIN.TEMP …	Displays minimum measured heatsink temp.
MAX.VOLTS …	Displays maximum measured battery voltage
RENTAL …	Displays total controller operation time NOTE: can be reset
ERASE RENTAL	Not available at password level 2
YES:ENTER, NO:ESC	ENTER resets rental datalog time to zero
VERSIONS	
GROUND …	Displays ground module software version
PLATFORM …	Displays platform module software version
ANALYSER …	Displays Analyzer software version

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SECTION 7. SCHEMATICS

7.1 GENERAL

This section contains schematics to be used for locating and correcting most of the operating problems which may develop. If a problem should develop which is not presented in this section or which is not corrected by listed corrective actions, technically qualified guidance should be obtained before proceeding with any maintenance.

7.2 TROUBLESHOOTING

It should be noted that there is no substitute for a thorough knowledge of the equipment and related systems.

It should be recognized that the majority of the problems arising in the machine will be centered in the hydraulic and electrical systems.

The first rule for troubleshooting any circuit that is hydraulically operated and electrically controlled is to determine if the circuit is lacking hydraulic oil and electrical control power. This can be ascertained by overriding the bypass valve (mechanically or electrically) so that oil is available to the function valve, then overriding the function valve mechanically. If the function performs satisfactorily, the problem exists with the control circuit.

7.3 HYDRAULIC CIRCUIT CHECKS

The best place to begin the problem analysis is at the power source (pump). Once it is determined that the pump is serviceable, then a systematic check of the circuit components, beginning with the control, would follow. For aid in troubleshooting, refer to the Illustrated Parts Manual for hydraulic diagrams of the various circuits.

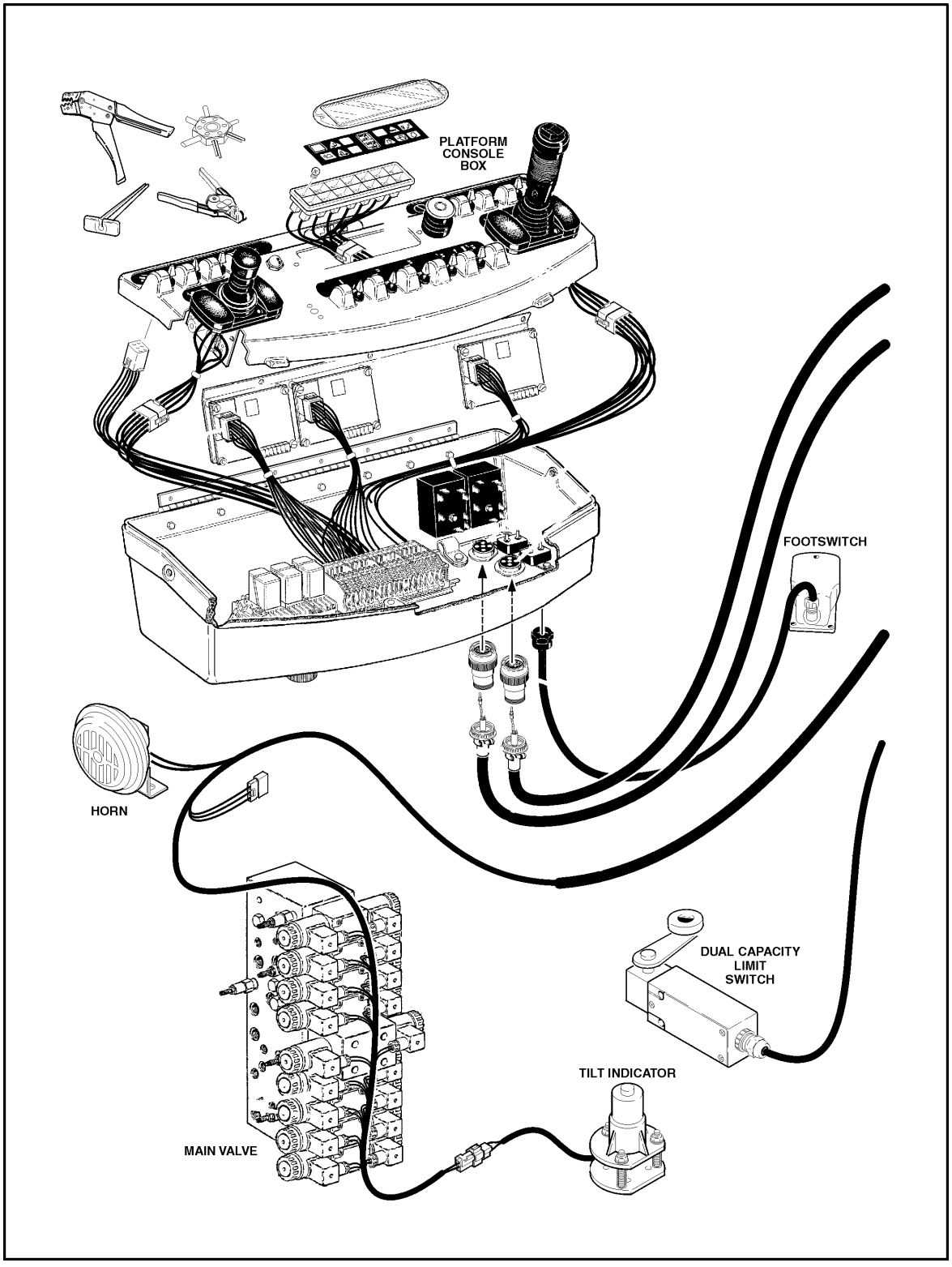

Figure 7-1. Electrical Components Installation (Prior to S/N 62137) - Sheet 1 of 2

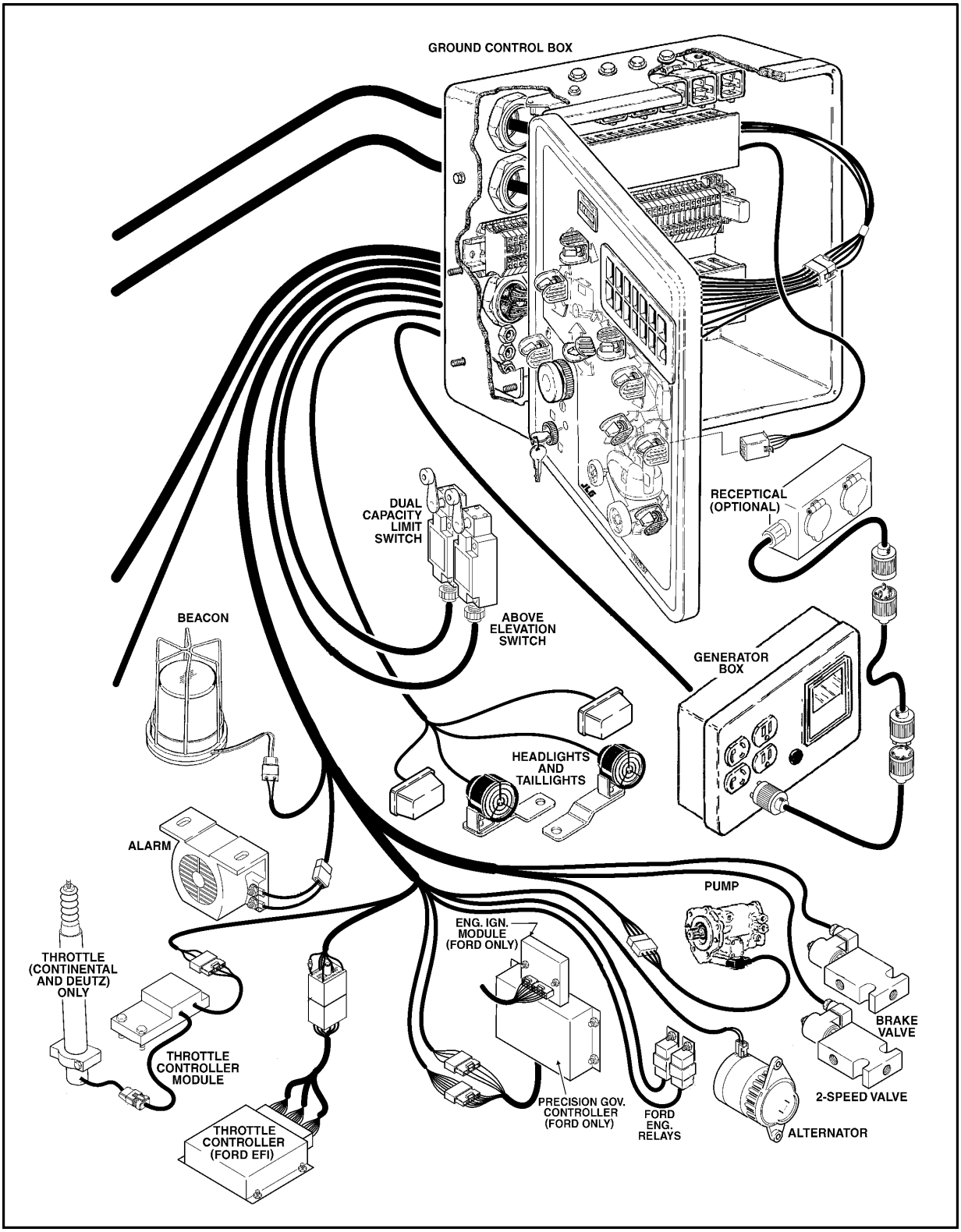

Figure 7-2. Electrical Components Installation (Prior to S/N 62137)- Sheet 2 of 2

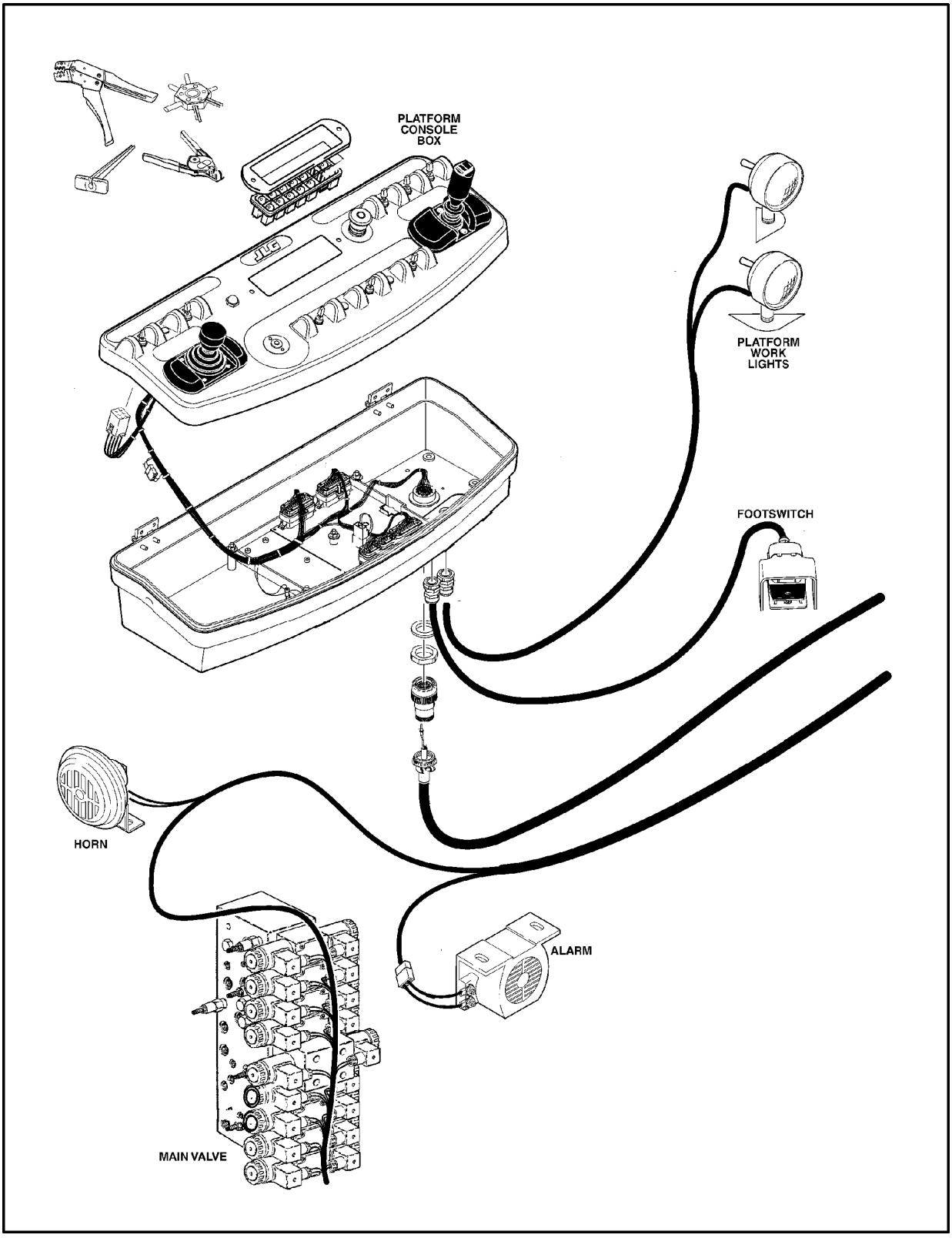

Figure 7-3. Electrical Components Installation (S/N 62137 to Present)-Sheet 1 of 2

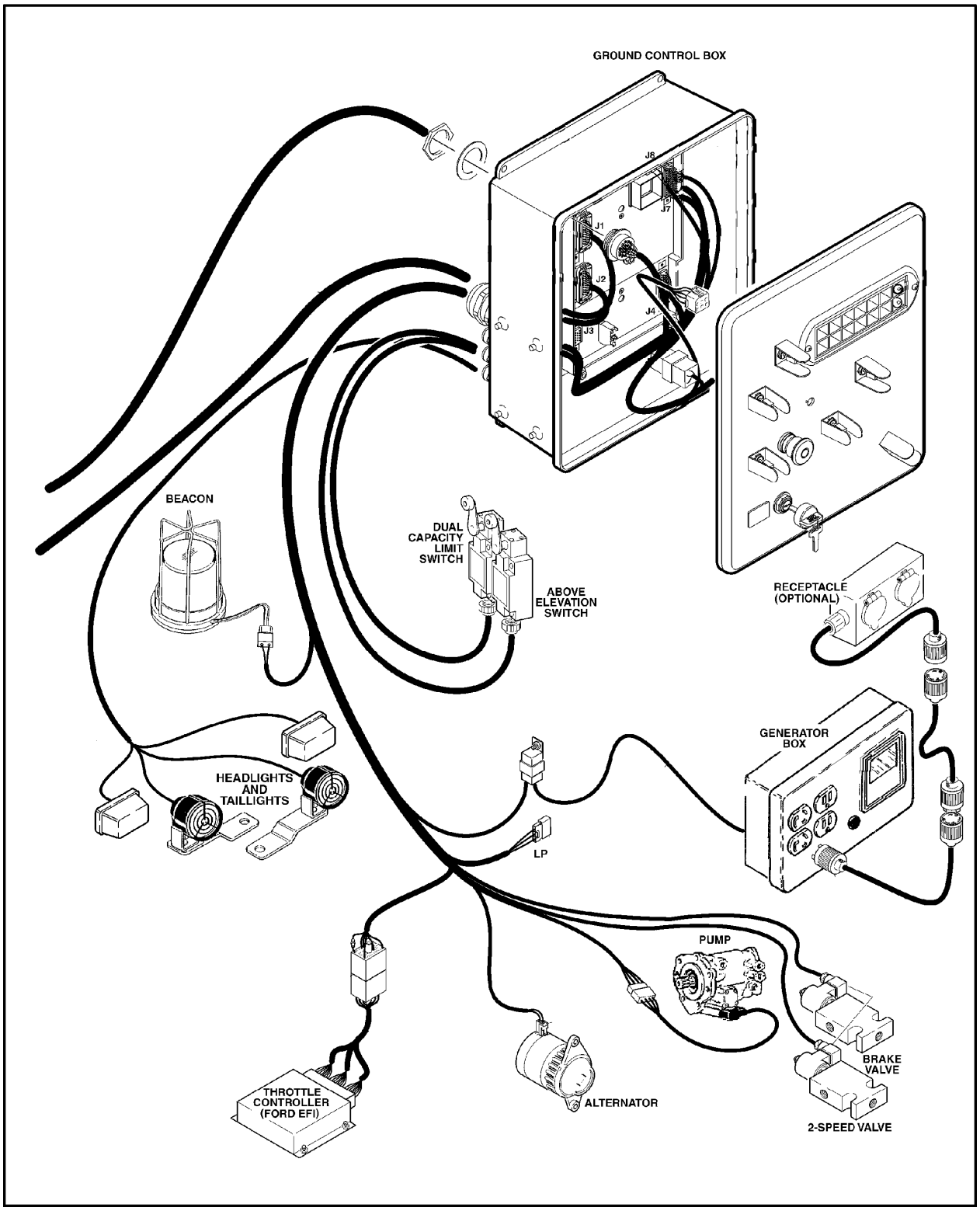

Figure 7-4. Electrical Components Installation (S/N 62137 to Present)-Sheet 2 of 2

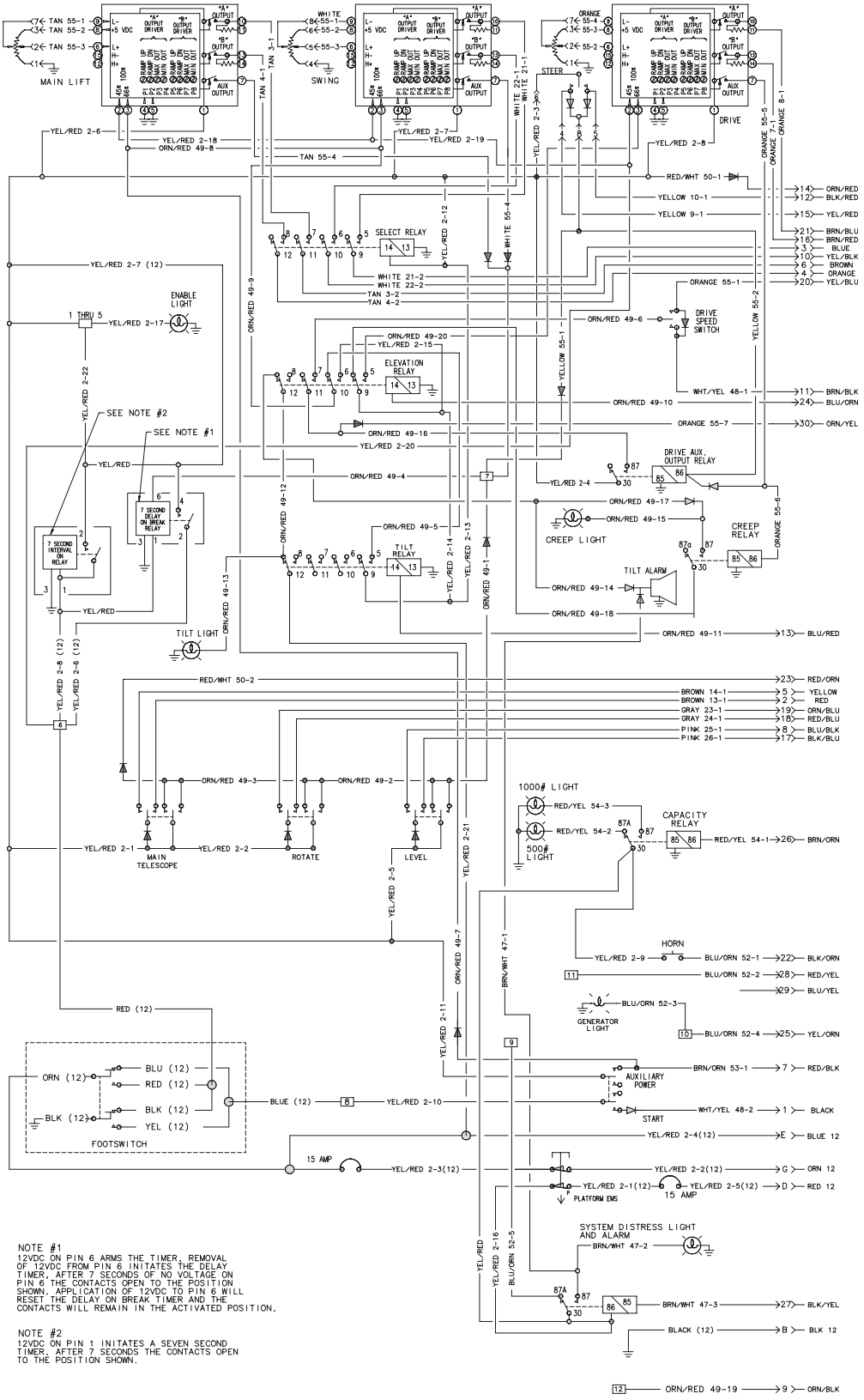

Figure 7-5. Electrical Schematic - Deutz Engine - Sheet 1 of 2

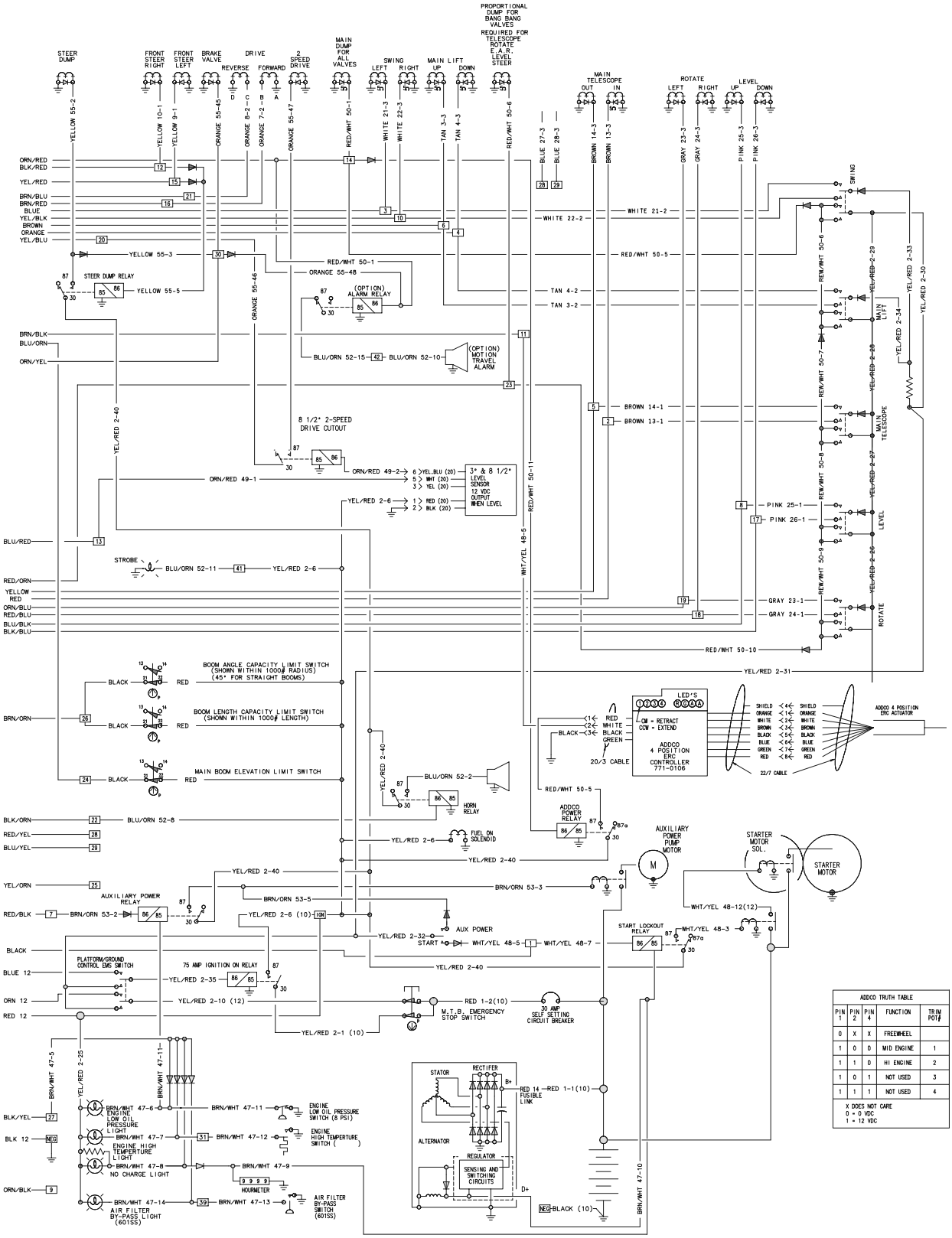

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Figure 7-6. Electrical Schematic - Deutz Engine - Sheet 2 of 2

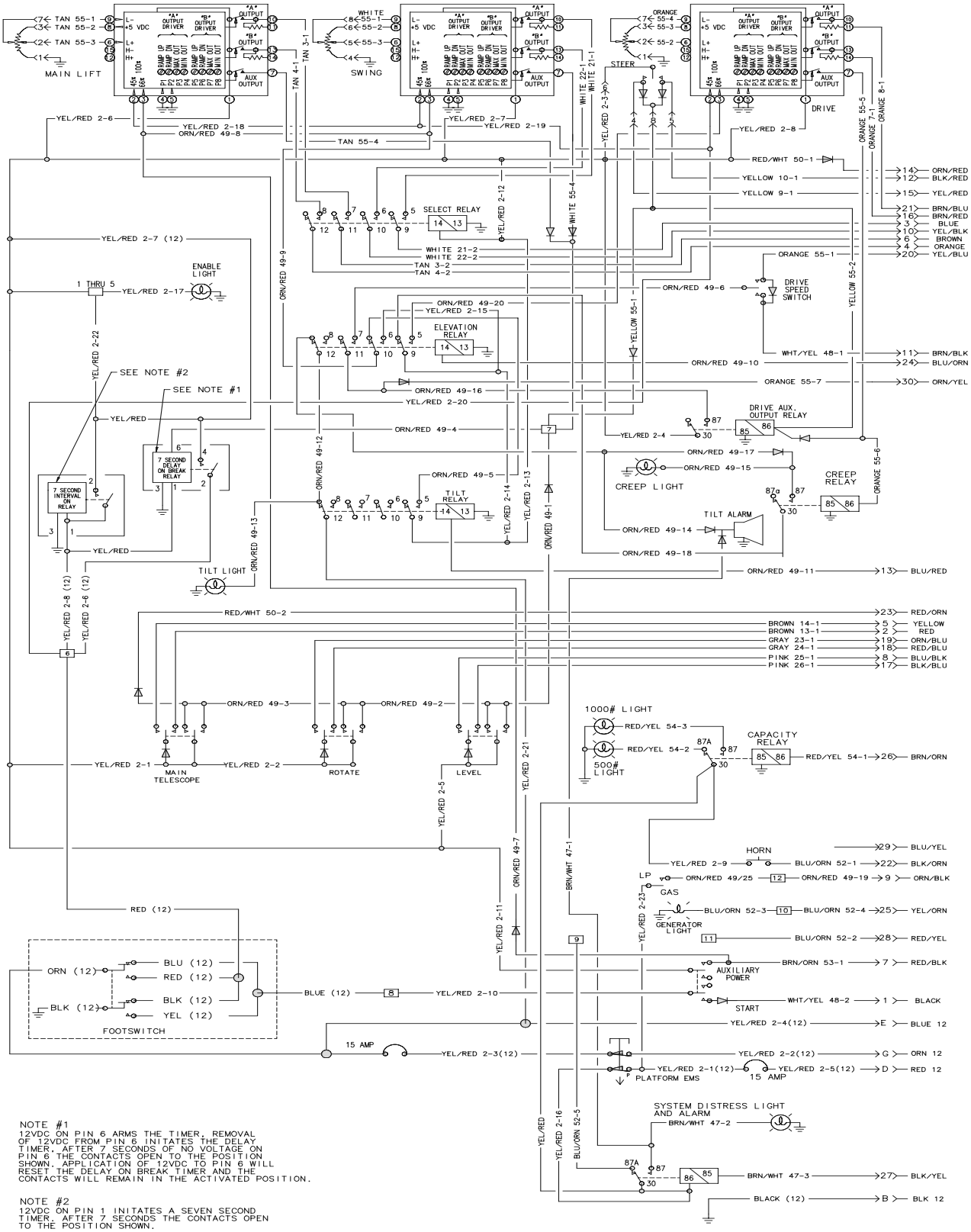

Figure 7-7. Electrical Schematic - Ford Dual Fuel Engine - Sheet 1 of 2

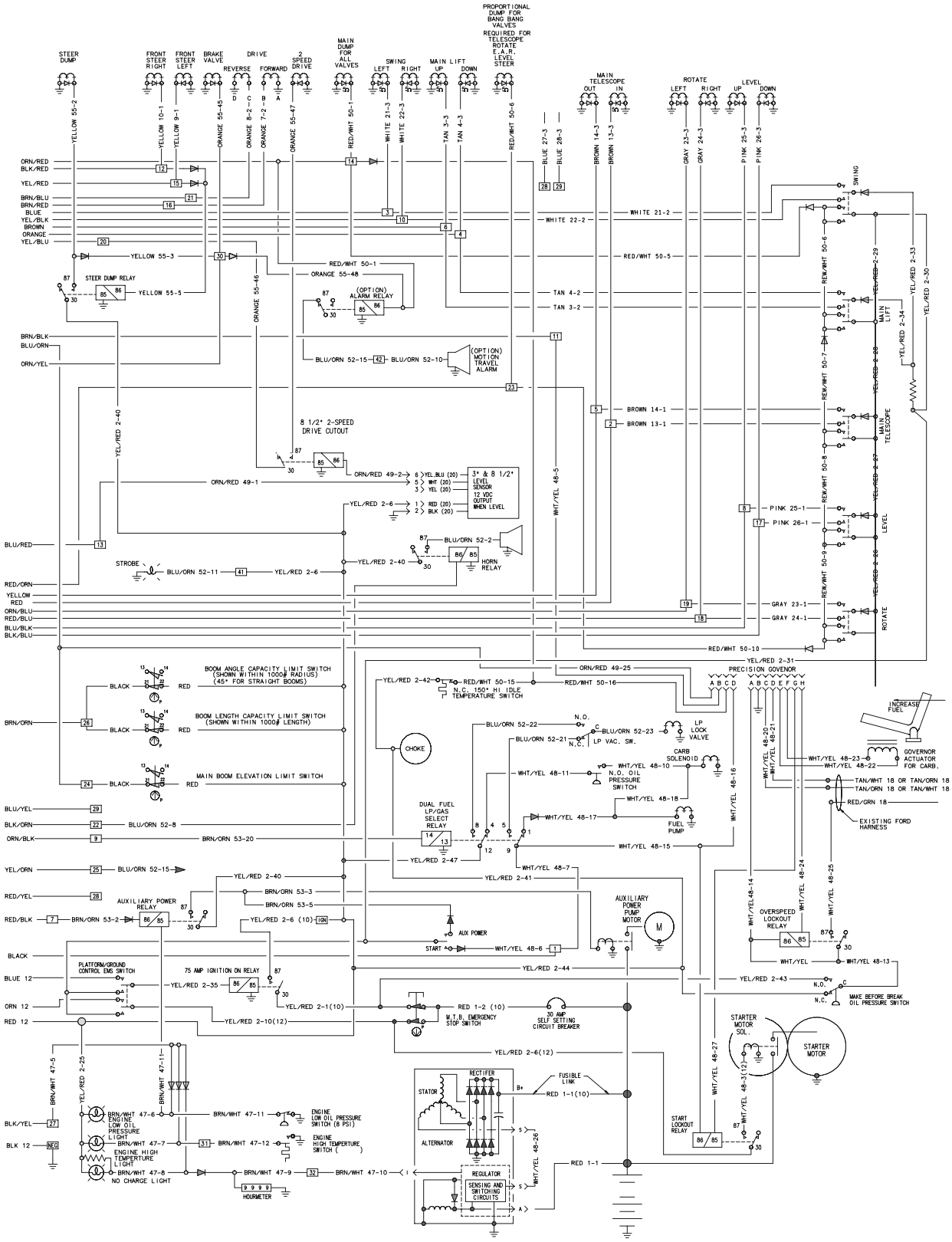

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Figure 7-8. Electrical Schematic - Ford Dual Fuel Engine - Sheet 2 of 2

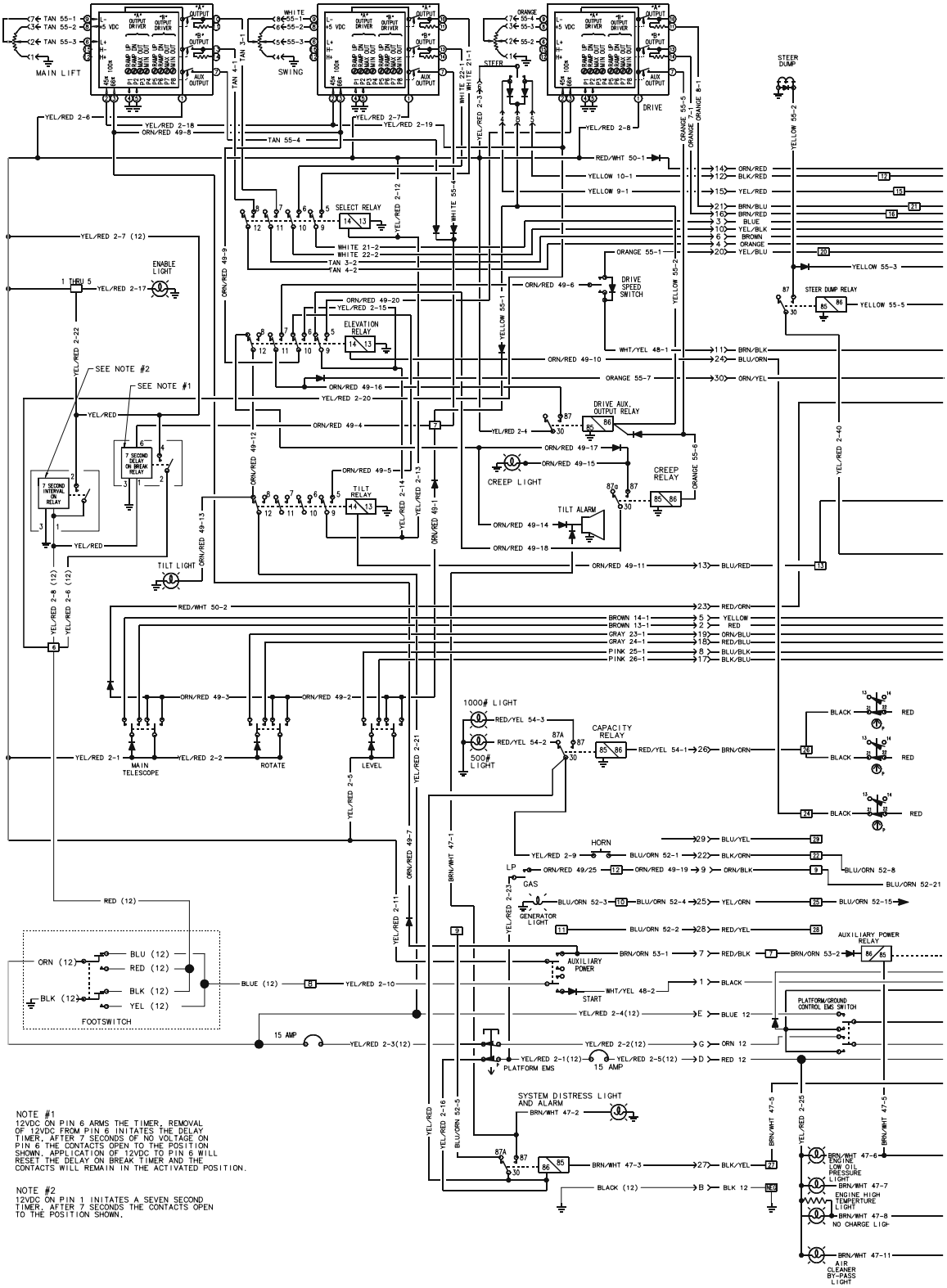

Figure 7-9. Electrical Schematic - Ford EFI Engine - Sheet 1 of 2

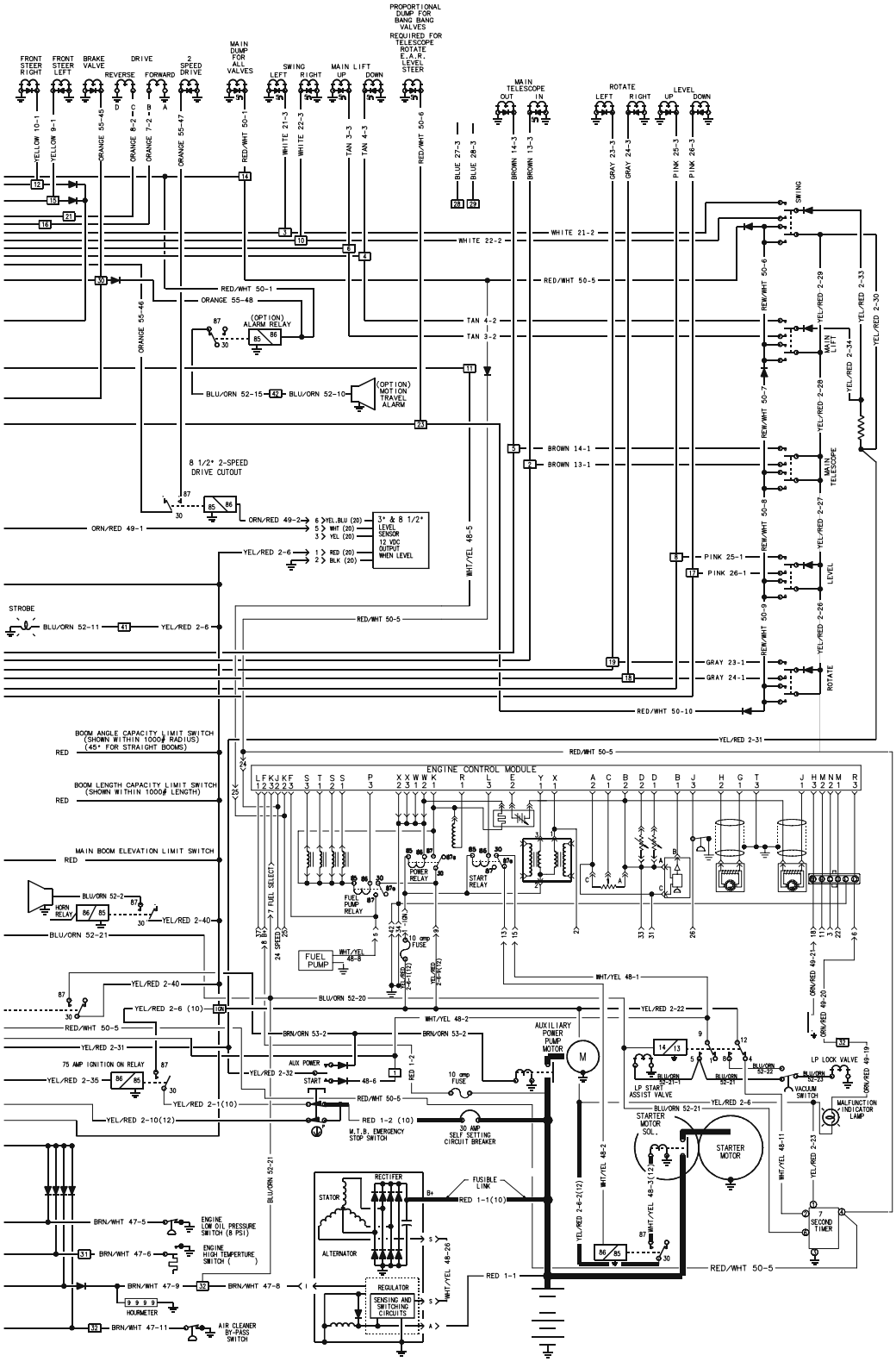

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Figure 7-10. Electrical Schematic - Ford EFI Engine - Sheet 2 of 2

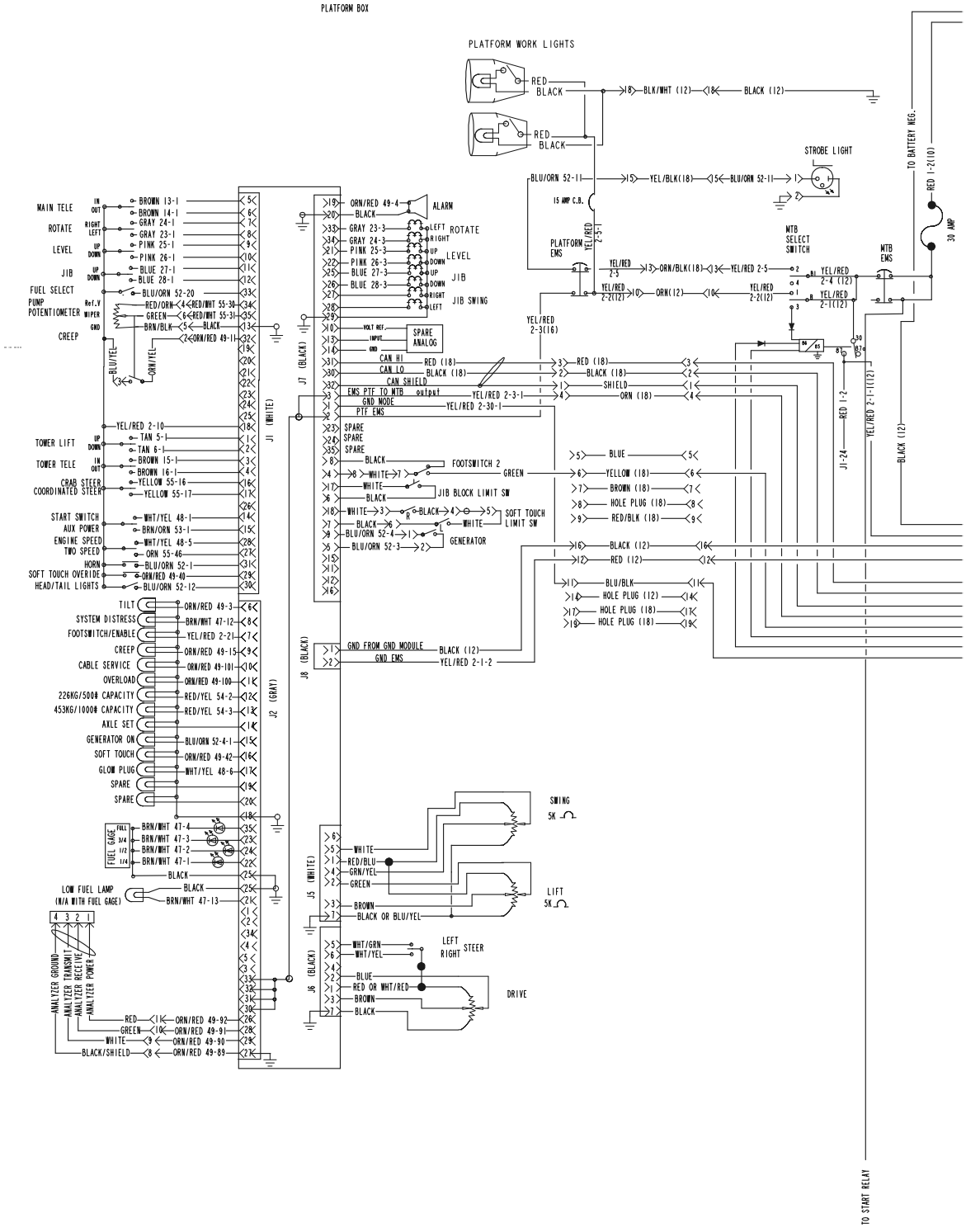

Figure 7-11. Electrical Schematic - ADE Machines - Sheet 1 of 4

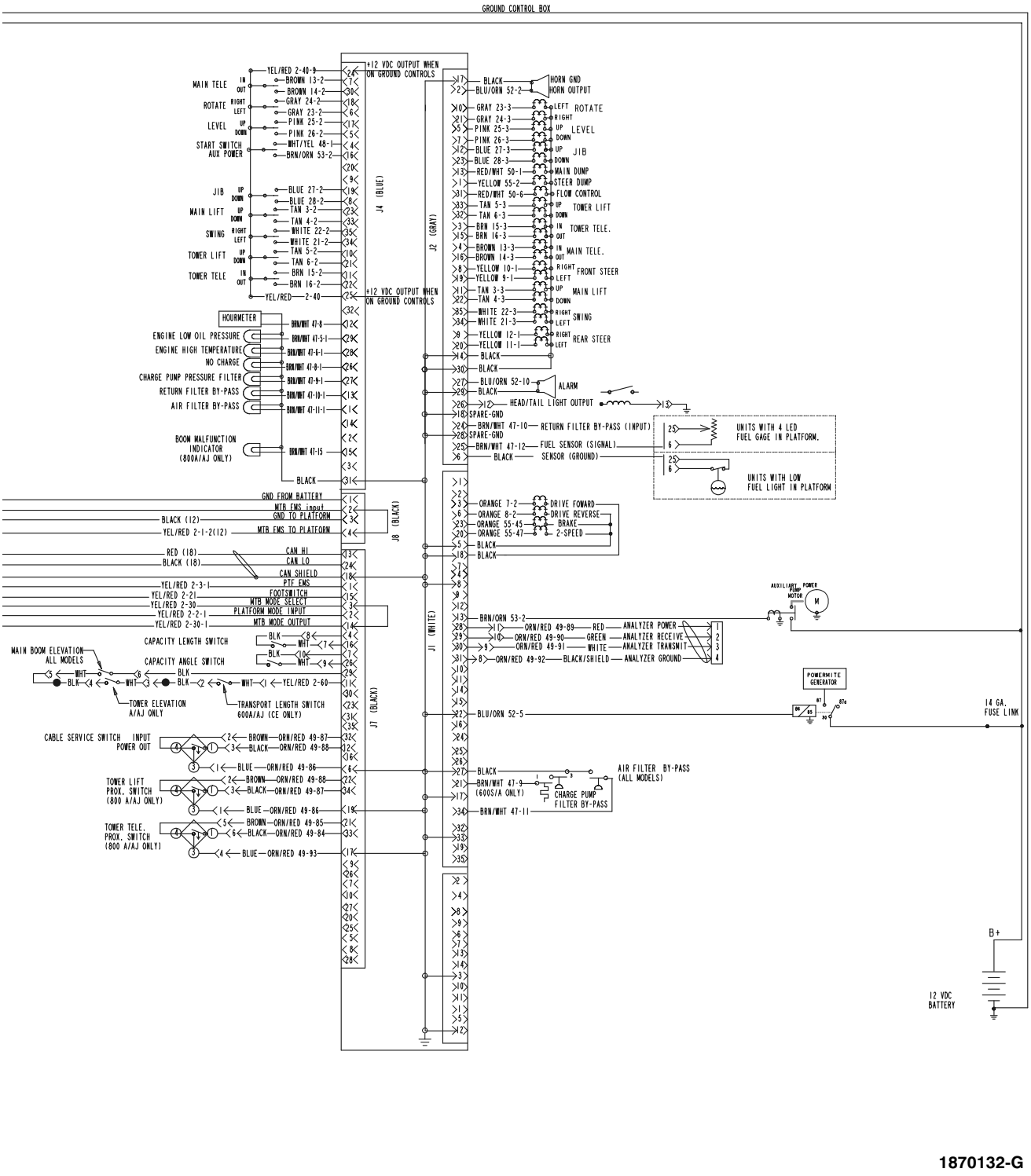

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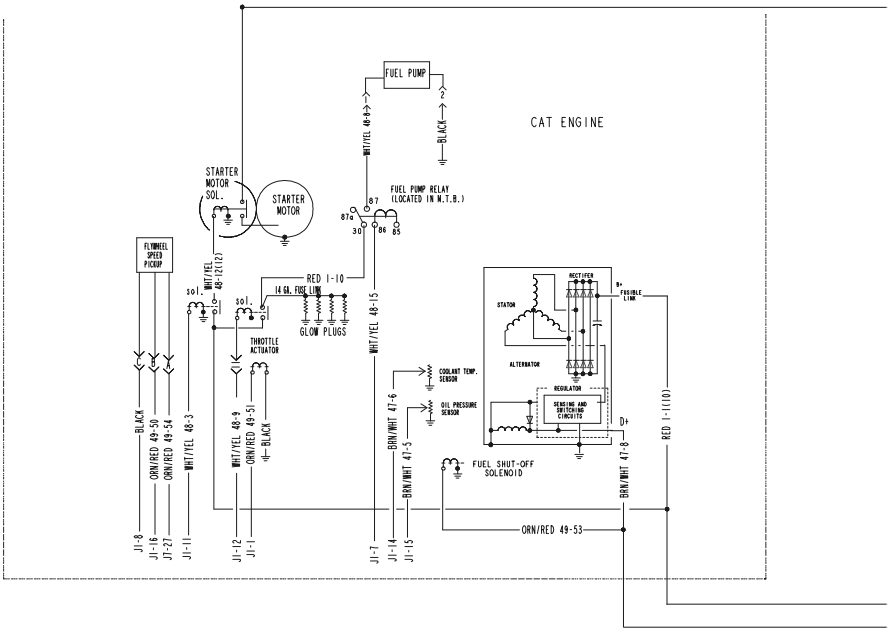
Figure 7-12. Electrical Schematic - ADE Machines - Sheet 2 of 4



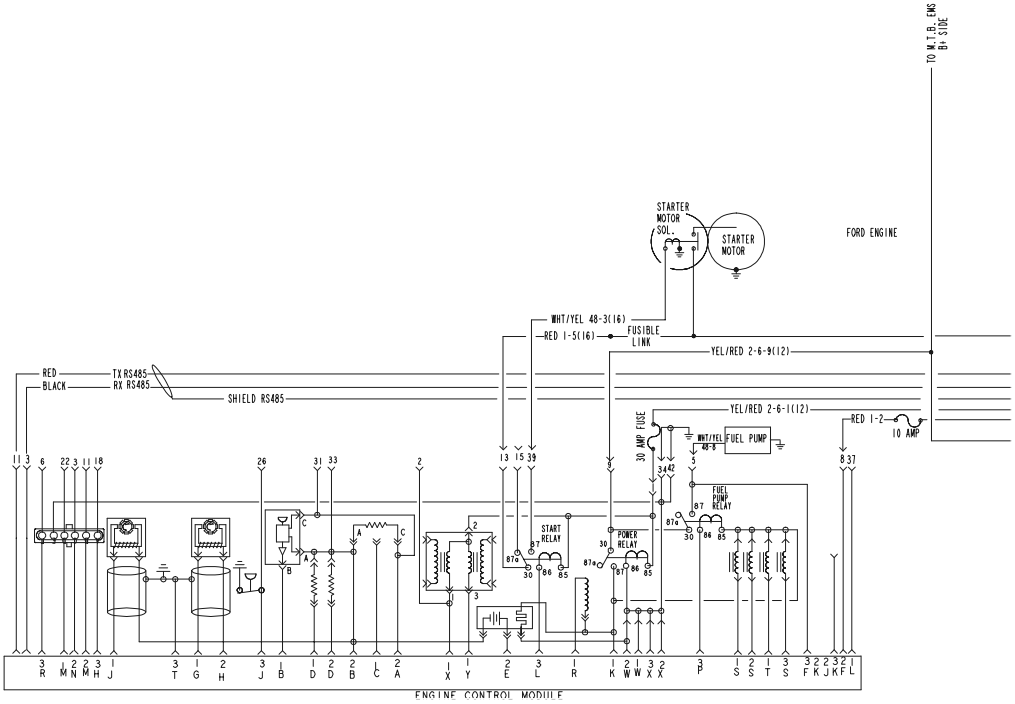


Figure 7-13. Electrical Schematic - ADE Machines - Sheet 3 of 4

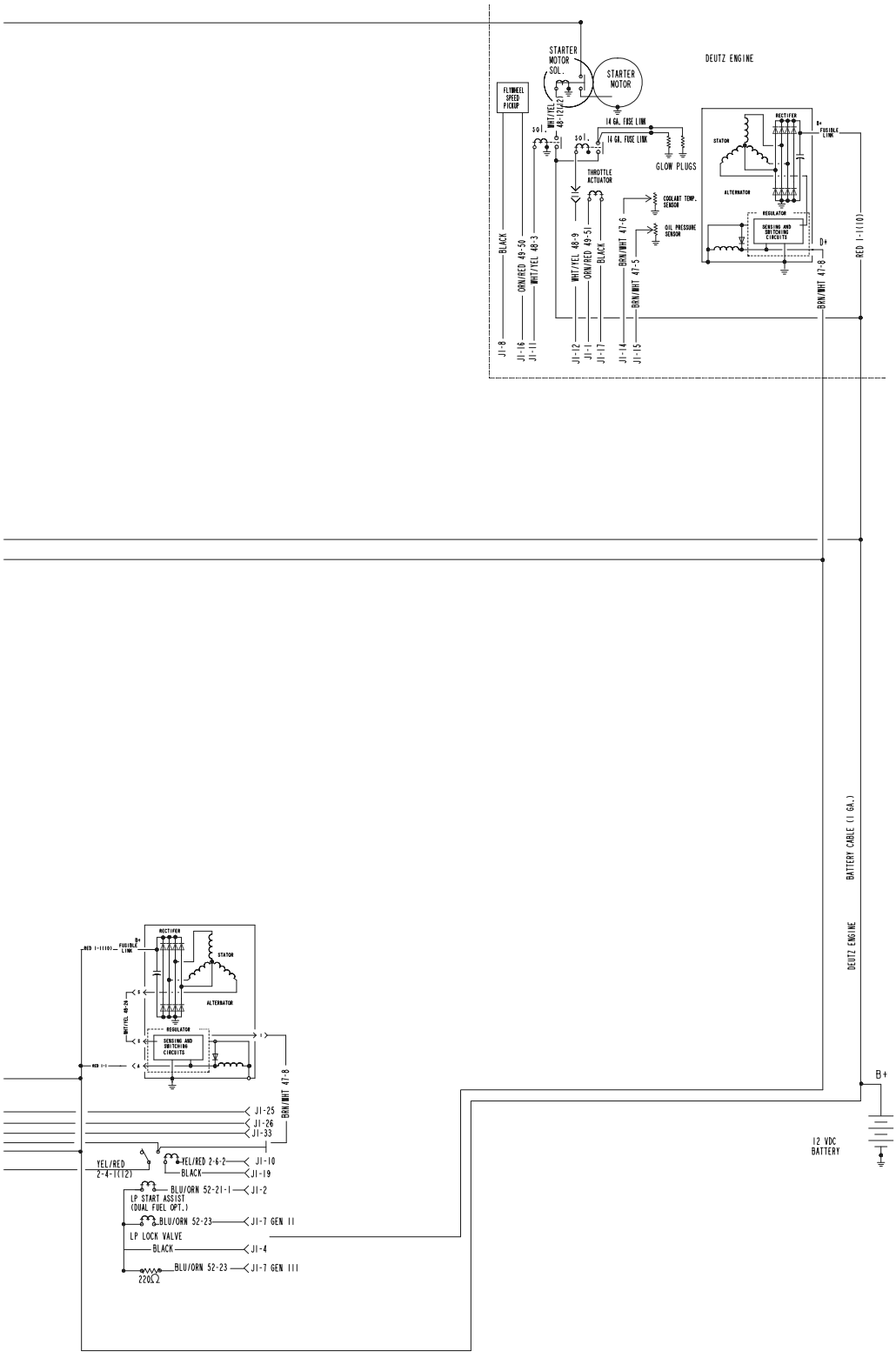


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Figure 7-14. Electrical Schematic - ADE Machines - Sheet 4 of 4

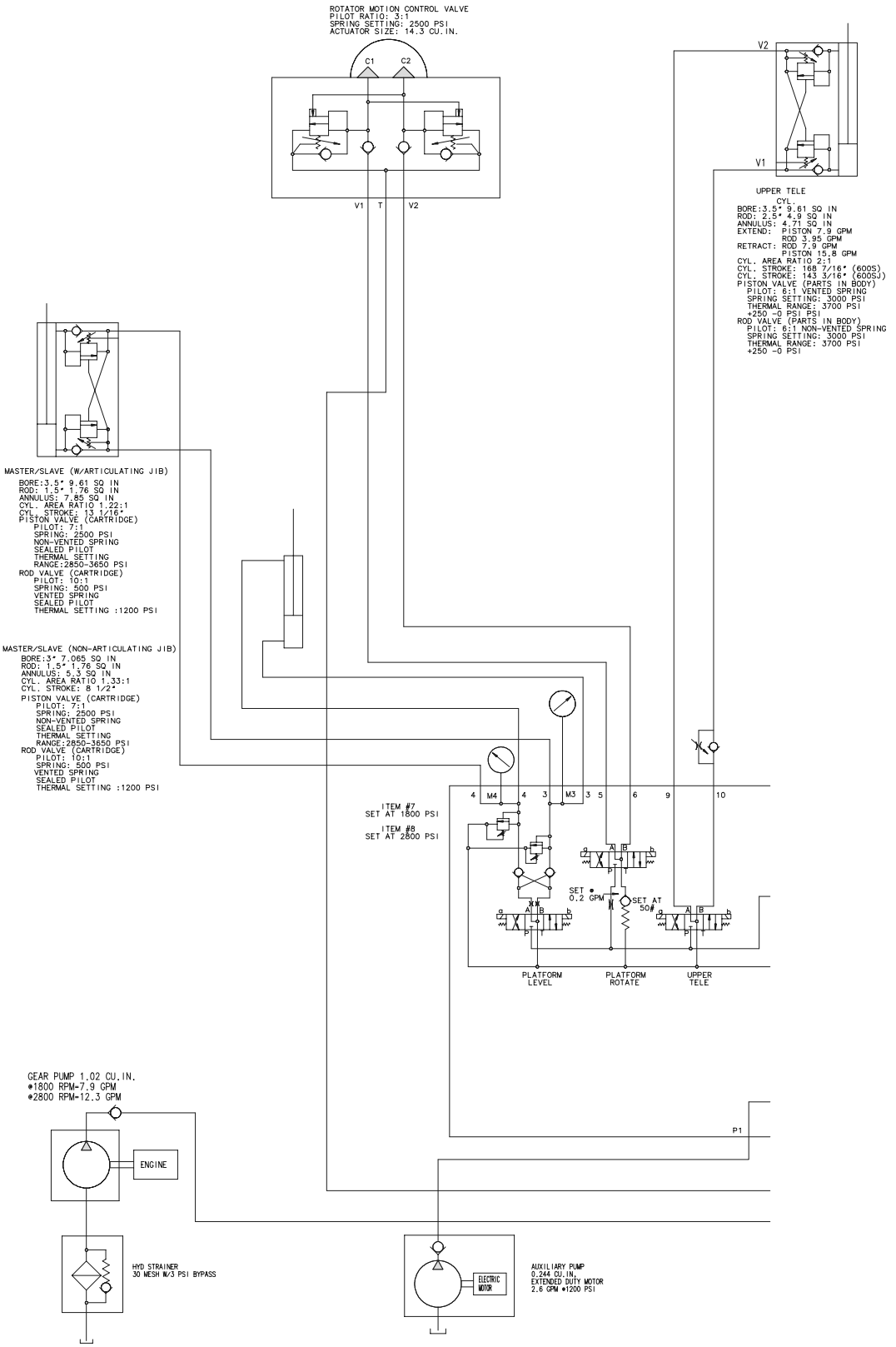

Figure 7-15. Hydraulic Schematic - Sheet 1 of 4

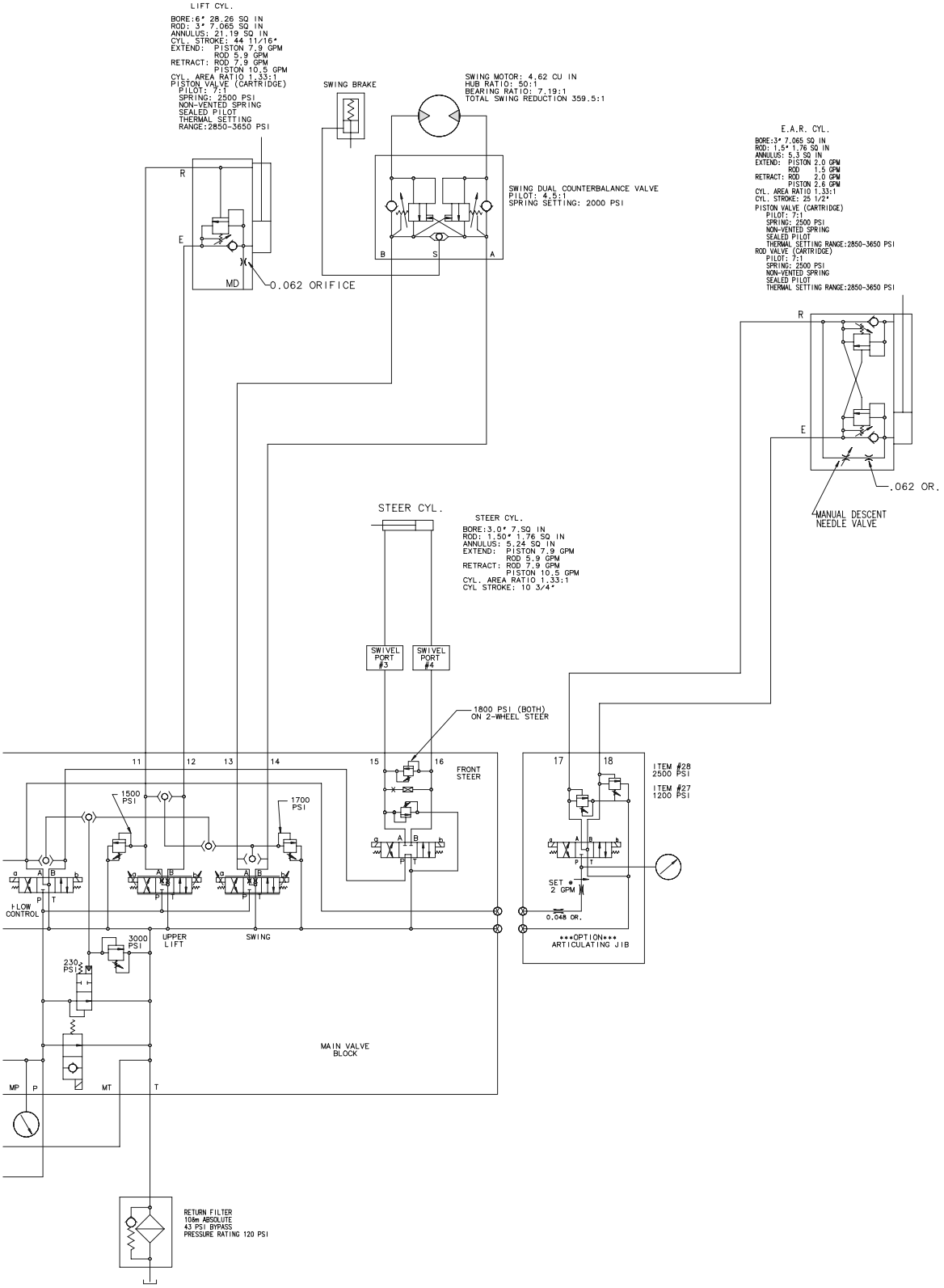

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Figure 7-16. Hydraulic Schematic - Sheet 2 of 4

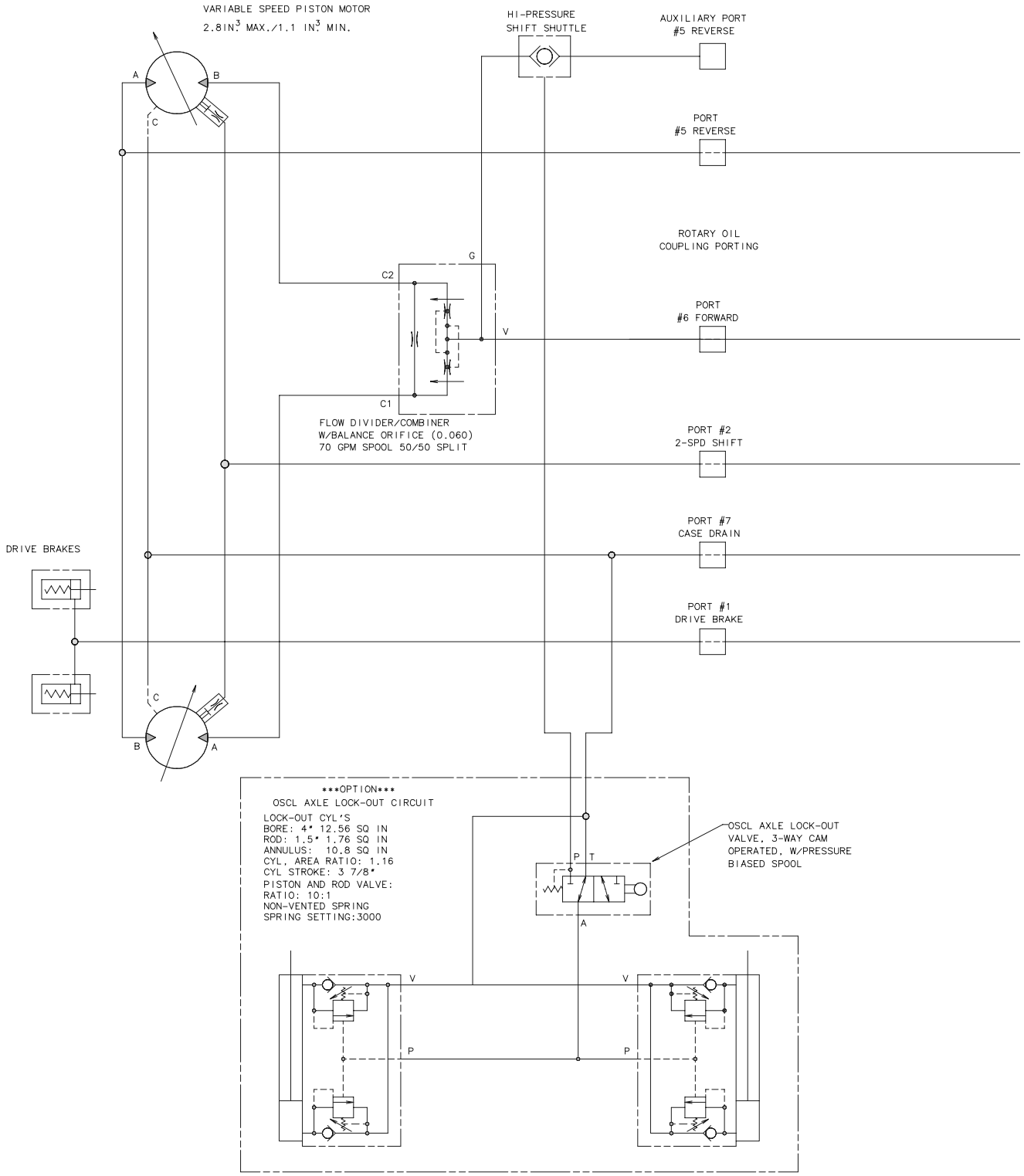

Figure 7-17. Hydraulic Schematic - Sheet 3 of 4

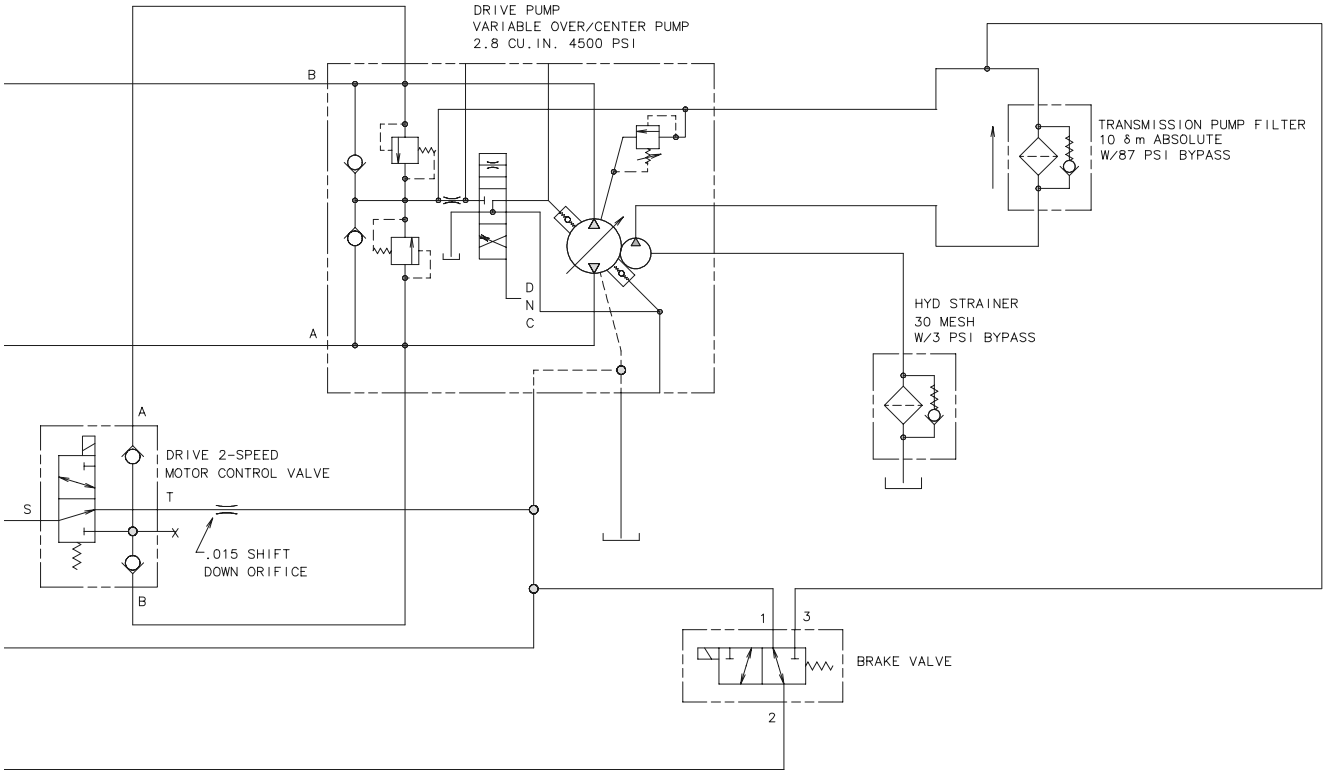

Figure 7-18. Hydraulic Schematic - Sheet 4 of 4

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